WORLD OIL

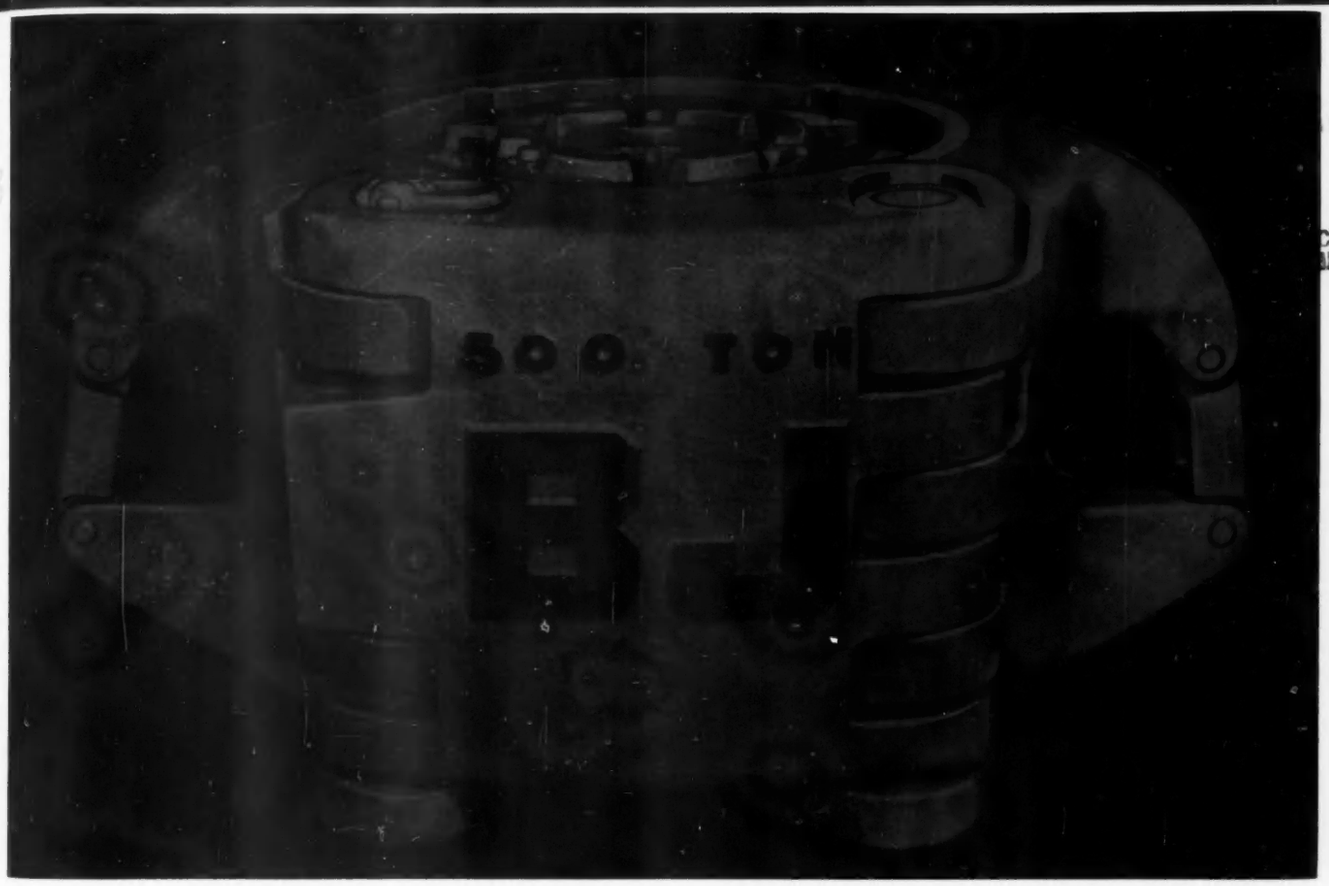
SPECIALIZED FOR EXPLORATION, DRILLING, PRODUCING OPERATIONS AND MANAGEMENT

A SPECIAL REPORT ON WATER-FLOODING

Treating of injection waters, cleanout procedures and selective plugging.

Pages 143-172

ERSITY OF MICHIGAN
LIBRARY
SCIENCE

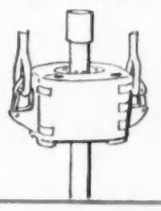


World's First 500-ton Elevator-Spider

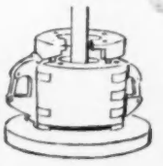
This tremendous new tool serves as either a casing elevator or as a casing spider. Its 500-ton capacity gives it a super-strength grip for holding the heaviest string of casing ever run or contemplated. Yet it is so simple and so functional that it can be easily operated by one man. Interchangeable slip assemblies and inserts make it capable of handling all casing sizes from 4½" to 10¾". This 5000-pound giant is designed for the deep drilling operations of today and of the future.

Write for bulletin containing complete specifications.

USED AS AN ELEVATOR



USED AS A SPIDER



WATCH BJ FOR THE NEWEST

Byron Jackson Tools, Inc.

A SUBSIDIARY OF BORG-WARNER CORPORATION

P.O. Box 2017A, Terminal Annex, Los Angeles 54, California • Cable: "BJTOOL"
Export Address: 580 Fifth Avenue, Suite 510, New York 36, New York

"talk about flow... this will be a real producer!"

With improved exploration techniques and improved drilling equipment . . . plus the ever spiraling demand for oil and gas . . . the New Year of 1958 should be a real producer! Joe Roughneck . . . heart of the petroleum industry . . . is certain to do one of the greatest jobs in his long and colorful career. Joe's efforts will be aided by his neighbor, Lone Star Steel . . . maker of top quality API casing, tubing and line pipe. Lone Star's big, completely integrated steel mill is dedicated to Joe Roughneck's team in the busy Mid-Continent area . . . and will deliver API pipe on the double.

Neighbor, wherever you are . . . specify Lone Star and we both get a good deal!

Lone Star STEEL COMPANY

EXECUTIVE SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas

DISTRICT SALES OFFICES

Houston, Texas
Tulsa, Oklahoma

Midland, Texas
Wichita Falls, Texas

Dallas, Texas
Shreveport, La.

Volume 146, No. 1 January, 1958

CURRENT OUTLOOK SECTION

	Page
Looking Ahead	71
Editor's Page	73
Offshore Oil to be Sought On U. S. Side of Lake Erie — H. T. Brundage	74
Check List Assures Good Report for Seeking Loan — C. R. Dodson	76
Do You Measure Decisions?	78
If Oil Could Speak	80
Keys to Effective Accident Control — J. L. Risinger	84
Changing Panorama: Lagging Demand Requires Strict Control of Supply — L. J. Logan	93
Report from the Observatory — Warren L. Baker	94
Petroleum Trends in the U. S.	94
Drilling Activities — Cecil W. Smith	96

EXPLORATION SECTION

Discovery Challenge of the Rockies — A. I. Levorsen	99
East Texas Basin Offers New Type Fields — Joseph A. Kornfeld	104

DRILLING SECTION

High Mud Pressures Increase Penetration — Ralph A. Watson and R. S. Sullins	113
The Effects of Weight and Speed on Penetration — Arthur Lubinski	120
Wire Rope Is a Machine and Needs Maintenance — C. E. Bogle and C. T. Evenden	122
Keys to Successful Competitive Drilling (Part 6B) — Roy A. Bobo, George S. Boudreaux and R. R. Angel	127
The Knowledge Box	140

PRODUCTION SECTION

Special Water-Flood Report: New Trends in Treating Waters for Injection — J. Wade Watkins	143
Selective Plugging of Input Wells — Dr. Holbrook G. Botset and Paul F. Fulton	152
Detergent and Citric Acid Aid Input Rates — R. T. Johansen, J. P. Powell and H. N. Dunning	160
Madison Block Flood in Mid-Continent Outstanding — R. L. Higginbotham and J. J. Williams	166
Significance of Oil-Water Contact (2nd in Series)	
Significance of Oil-Water Contact (2nd in Series) — Frank W. Cole	174
Determining the Viscosity of Crude — Dr. D. S. Davis	177

INTERNATIONAL SECTION

Drilling and Exploration to Increase in Cuba	179
Need for New Oil Spurs Exploration in Israel	180
What's Happening Among World Oil Men	181
A World of Oil	182

DEPARTMENTS

Who's Meeting Where	69
Drilling Hints	190
Production Hints	199
What's Happening Among Men in the Industry	213
Companies in the News	218
Association News	220
What's Happening Among Service and Supply Men	222
Classified Advertising	227
Trading Post	227
Squeaks from the Bullwheel	228

NEW EQUIPMENT SECTION

What's New in Equipment	234
New Equipment Catalogs and Literature	243
ADVERTISERS' INDEX	244

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at post office at Houston, Texas, under the act of March 3, 1879.

WORLD OIL

Established 1916 as The OIL WEEKLY

UNIVERSITY OF MICHIGAN
1985
JAN 14 1958
8853
SCIENCE LIBRARY

a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **Pennsylvania is the first state in the U. S.** bordering on Lake Erie to lease offshore tracts, although it has a shorter Lake Erie shore line than either of its neighbors, Ohio and New York. In those states known production continues to the shore line and ends there only because of lack of offshore drilling. There is production both onshore and offshore across Lake Erie in Ontario. Pennsylvania expects to lease more tracts in the future, in addition to the 35,630 acres already assigned to New York State Natural Gas Corporation. Ohio and New York State can be expected to follow Pennsylvania's lead in the near future. To learn the prospects and the problems involved turn to **Page 74. Offshore Oil to Be Sought on U. S. Side of Lake Erie**.....**H. T. Brundage**

☐ **A bank must have complete information** on an oil or gas producing property before it will make a loan on the property. The First City National Bank of New York has prepared a system or check list to be followed by the operator in seeking a loan. Application of the check list will make it easier to obtain a loan. See **Page 76. Check List Assures Good Report for Seeking Loan**.....**C. R. Dodson**

☐ **Most articles on operations research** are too general or they deal with various techniques which tend to confuse clear understanding of the method. This article does neither. In a concise, clear style the author explains operations research, outlines its applications and shows, in simple terms, how to set it up for profitable use. **Do You "Measure" Decisions? Page 78**

☐ **If you're planning to re-vamp an old safety program** or start a new one, be sure to check the suggestions offered here by one of the nation's top safety and fire authorities. You will find all the basic essentials you need to organize an effective safety program starting on **Page 84. Keys to Effective Accident Control**.....**J. L. Risinger**

Turn the Page ▸

Water-flood articles in this issue reflect the opinions of experts on . . .

- Treating injection water . . 143
- Selective plugging of input wells 152
- Treating sand-face plugging with acid-detergent . . . 160
- A Mid-Continent flood that paid off 166

☐ **Very substantial benefits may be derived** from a systematic and carefully conducted selective plugging program. Records on the performance of some floods are presented on **Page 152** in order to show other operators the advantage of this system. For a number of years South Penn Oil Company, Bradford, Penn., has been selectively plugging hundreds of wells and keeping careful records on the performance of the floods involved. **Selective Plugging of Input Wells** . . . . . **Dr. Holbrook G. Botset,** and **Paul F. Fulton**

☐ **A more lasting increase in the injection rate** was obtained with a continuous or intermittent injection of citric acid and detergent. Wellhead tests conducted on several injection wells after citric acid and detergent treatment, indicated improved skin effects and increased injection rates. Citric acid solution proportioned into the injection water caused a large increase in the injection rate for a short period. See **Page 160. Detergent and Citric Acid Aid Input Rates** . . . . . **R. T. Johansen, J. P. Powell** and **H. N. Dunning**

☐ **Successful oil recovery from efficient waterflooding demands** an adequate knowledge of the treatment required for injected brines and surface waters. This phase of secondary recovery is becoming a technology in itself. For a "between covers" review of recent trends in this important phase of oil production, see **Page 143. New Trends in Treating Waters for Injection?** . . . . . **J. Wade Watkins**

☐ **An increase in production** from 150 to 1400 barrels a day took place in the Madison Block Unit in Kansas. For a description of this project, see **Page 166. Madison Block Flood in Mid-Continent Outstanding** . . **R. L. Higginbotham** and **J. J. Williams**

EXPLORATION ARTICLES

☐ **Are there substantial quantities of oil** remaining to be discovered in the Rocky Mountain area? If so, can they be uncovered? For further details on this timely topic, turn to **Page 99. Discovery Challenge of the Rockies** . . . . . **A. I. Levorsen**

☐ **A great stimulus to the search for petroleum** in the East Texas Basin has been a series of recent significant discoveries. Three different types of exploration are involved. They include prospecting on the hitherto unproductive interior salt domes, deep drilling along pronounced fault zones, and stratigraphic exploration of the south rim of the basin. Discoveries on the flanks of several interior salt domes and along fault segments of the Mexia and Talco fault systems point up new sources of petroleum from the Jurassic, Cretaceous and Eocene rocks. See **Page 104. East Texas Basin Offers New Type Fields** . . . . . **Joseph A. Kornfeld**

DRILLING ARTICLES

☐ **South Louisiana has established improved penetration rates** by using up to 1500 hydraulic horsepower. A discussion of the effects of mud weight, fluid loss, and pipe size on hydraulic horsepower is presented on **Page 113. High Mud Pressures Increase Penetration** . . . . . **R. A. Watson** and **R. S. Sullins**

☐ **Considerable time and attention** has been spent on the study of the effects of weight and speed on rotary penetration rates. Here in a prepared discussion of the AAODC committee's report the author advocates the use of very short depth increments to assure constant formation characteristics. Facts to support this contention are presented in the article on **Page 120. The Effects of Weight and Speed on Penetration**..... **Arthur Lubinski**

☐ **Interesting dividends through reduced** costs and higher operating efficiencies will come to the operator by proper care and maintenance of wire rope. Turn to **Page 123. Wire Rope Is a Machine and Needs Maintenance**.....**C. E. Bogle** and **C. T. Evenden**

☐ **Spectacular increases in penetration rates,** bit life and footage per bit have resulted from the judicious use of air and gas drilling. Presented here are these favorable results as well as a discussion of the many problems that must be overcome before this drilling method can be universally accepted and applied. For full engineering data on this method of drilling see **Page 127. Keys to Successful Competitive Drilling (Part 6B)—Air and Gas Drilling**....**Roy A. Bobo, George S. Boudreaux** and **R. R. Angel**

OTHER PRODUCTION ARTICLES

☐ **The second in a series** of articles on expanding gas cap reservoirs showing the significance of the oil-water contact. The term is defined as the lowest structural position in the reservoir from which 100 percent oil can be produced. Substantial oil can possibly be produced below the oil-water contact, depending on the thickness of the transition zone, and could possibly have an economic bearing on reserve evaluations where this zone is relatively thick. See **Page 174. Significance of The Oil-Water Contact**.....**Frank W. Cole**

☐ **Use this simple nomograph** to find the viscosity of gas saturated crude oil at pressures above the saturation (bubble point) pressure if the viscosity at saturation pressure is known. See **Page 177. Determining the Viscosity of Crude**.....**D. S. Davis**

INTERNATIONAL ARTICLES

☐ **Cuba is looking forward to important progress** in its oil development operations as a result of exploration and test drilling activity planned by several large companies. For a quick summary of what is happening on the island, read . . . **Drilling and Exploration to Increase in Cuba**.....**Page 179**

☐ **With 18 wells on production in Israel's Heletz field,** described as thoroughly developed, and three wells capable of production at Brur oil field, the nation's continuing need for new oil and more oil is spurring exploration efforts. For a glance into current operations in the Negev see . . . **Need for New Oil Spurs Exploration in Israel**.....**Page 180**

Order Your Index Now

ANOTHER YEAR and another annual WORLD OIL Editorial Index is already in the hands of the printer. This convenient index, an annual service to WORLD OIL readers, will cover all issues published during 1957 and be bound in convenient pamphlet form. It will be sent FREE to all subscribers requesting copies.

All articles which appeared during 1957 are indexed by author and by subject matter for quick reference. Hundreds of our readers requested copies of the 1956 index. We have tried to estimate the demand this year, but to be certain of your copy, send in your request early. The supply will be limited.

To get your copy, address your order to: Librarian, Gulf Publishing Company, Post Office Box 2608 Houston 1, Texas. Or if you prefer, you can use the convenient Readers' Service Blue Postcard just inside the back cover of this and every issue of WORLD OIL. Merely check the square indicated, fill in your name and address, and drop the postage-paid card in the mail. The annual WORLD OIL Editorial Index will be sent you by return mail.

Do it now. The supply will be limited.

We'll Be Seeing You

WHEN YOU ATTEND each of your 1958 society or association meetings, it is more than likely that you will see (and meet, we hope!) one or more WORLD OIL staff members. And don't be surprised, for they will be only a part of the team which this year, as in the past, will search throughout the U. S. for information of value to you.

In all, WORLD OIL staff members' travel schedule for the first six months of 1958 calls for them to spend a minimum of:

- **70 days in attendance at more than 18 national and regional meetings.**
- **50 days in visiting and traveling through oil and gas fields and areas likely to be opened for exploration.**

When WORLD OIL's travel schedule for the last six months of 1958 is completed, it, too, will reflect the sizable and intense effort being made to provide information which is *useful* as well as *interesting* to you.

And, by the way, when you see a WORLD OIL staff member, he'd appreciate your own ideas for articles. You see, it's his job to work for you.

NEXT MONTH . . .

Feb. 15 WORLD OIL To Answer Big Need For Statistical Data

YOUR INDUSTRY'S condition . . . its problems . . . its hopes . . . its "soft" spots . . . its bright spots?

You will find them all pinpointed, analyzed and graphically illustrated in your copy of WORLD OIL's forthcoming Forecast-Review Issue.

Scheduled for publication February 15, this special effort looks into the past, present and future of all phases of the domestic and international petroleum industry—information requisite to your own evaluation of . . .

What's Ahead in '58?

With an industry beset by intensifying problems—both external and internal—the current need for authoritative forecasts and statistical data is particularly great.

Beginning with the ever-important demand analysis, this WORLD OIL "three-in-one" special issue will weave together the past, present and future of drilling, exploration and production into a single-package presentation. The data will serve as guides to the earnings of not only oil companies but also—and invariably—the individuals who *are* the industry.

Comprehensive analyses, tables and charts projected with outlook trends and supported by historical review data—supplied by no other source—will afford WORLD OIL readers an easily accessible year-around reference to the present and future potential of their industry, their companies and themselves.

. . . And it will be published February 15—a date dictated by availability of reliable, industry-accepted data reflecting actual past year statistics.

Remember. It's the annual WORLD OIL Forecast-Review Issue, and the date is February 15.

WORLD OIL

RAY L. DUDLEY, Founder, 1891-1957

WILLIAM G. DUDLEY.....Publisher
TOM W. NELSON.....General Manager
R. M. DE SOMBRE.....Assistant General Manager
WARREN L. BAKER.....Editorial Director
DONALD E. KLIEWER.....Editor
L. J. LOGAN.....Associate Editor, Economics
JOHN N. SCHUELKE.....Associate Editor, Technical
WALLACE FITZGERALD.....Managing Editor
CECIL W. SMITH.....Statistical Editor
PERRY R. HILLEGEIST.....Engineering Editor
JOHNNY H. HEDRICK.....Engineering Editor
DON E. LAMBERT.....Management and Personnel Editor
GILBERT M. WILSON.....Western District Editor
ANTHONY GIBBON.....Mid-Continent District Editor
HARRISON T. BRUNDAGE.....Eastern District Editor
JACK COCKERHAM.....Presentation Editor
FERN C. REED.....Editorial Assistant
MARGARET McKENZIE.....Editorial Assistant
KATHERYNE BAST.....Editorial Assistant
EUNICE M. OKONESKI.....Librarian

ADVERTISING

Nelson Bigelow, Advertising Sales Manager. *Representatives:* NEW YORK (17): Sam Sorrell, Gene Hart, George Skelton, 250 Park Ave., Phone YUkon 6-6558; CLEVELAND (15): Bill Westfall, Harvey Dunn, 1010 Euclid Ave., Phone MAin 1-3295; CHICAGO (4): H. G. Fitzpatrick, Martin Halloran, 332 So. Michigan Ave., Phone Wabash 2-9330; LOS ANGELES: Jay Curts, W. W. Wilson Bldg., Huntington Park, Phone Ludlow 7-1219; TULSA (3): Jim Isaacks, 916 Enterprise Bldg., CHerry 2-9211; DALLAS (2): Ed Thompson, Room 518, Second Unit, Santa Fe Building, Phone RIverside 7-7344; HOUSTON (19): Charles Wyatt, James W. Merrill, 3301 Buffalo Drive, Phone JAckson 9-4301; EUROPEAN: Theodor Miocha, Agent, Limmerstrasse 31, Hannover, Germany, Phone 4-2935; UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London, E. C. 2, Phone Monarch 5661. Advertising rates on application.

SUBSCRIPTIONS

T. A. Gaden, Subscription Manager, P. O. Box 2608, Houston, Texas, U. S. A.

Single copies 50 cents (except special issues). Double prices for single copies more than one year old. Subscription price: domestic and foreign, $2 a year.

WORLD OIL published every month except semi-monthly in February and August. Copyright, 1958, by The Gulf Publishing Company. WORLD OIL and THE OIL WEEKLY are registered trademarks of The Gulf Publishing Company, Houston, Texas.

Specialized oil publications of THE GULF PUBLISHING COMPANY 3301 Buffalo Drive, Houston 19, Texas; Box 2608, Houston 1, Texas. Cable Address: GULFPUBCO.

WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing industry.

PETROLEUM REFINER and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

PIPE LINE INDUSTRY and THE PIPE LINE COMPOSITE CATALOG for the oil and gas pipe line industry.

Indexed by Industrial Arts Index and Engineering Index

Looking Ahead . . .

Little Shortage of Long Term Loans . . . Despite money shortage, there is little shortage of long term oil financing funds. It is easier to finance 15-year payout loans than 5-year loans. This is because so much of the loan money available today comes from trust funds which are interested in keeping money at work.

Strict Proration Boosts Texas' Reserves . . . The 12-day per month producing schedule in Texas during recent months will increase ultimate recoveries in a number of fields. Bottom-hole pressures have increased in a good many fields. This will prove to be a bright spot in what everyone has considered a very dark picture.

More Carbon Black Plants Likely . . . Carbon black has been in very short supply since the war. Higher U. S. gas prices have reduced profits. Supply now becoming more and more critical. Look for construction of more carbon black plants in sour gas areas.

Less Cycling Plant Construction . . . Fewer new cycling plants are likely to be built in the future. Many of the wet gas fields being found today in the U. S. are too small to economically warrant the construction of such plants.

More Salt Water Disposal Wells . . . An increase in the number of salt water disposal wells drilled in Kansas is in prospect. Kansas recently has put some teeth in its salt water disposal laws. No open surface pits will be permitted after January 1, 1958.

Improved, Cheap Lease Roads . . . Use of oil field brines as a packing agent on lease roads is proving successful in many areas.

Gas Producers Should Look for Helium . . . U. S. gas producers are overlooking a fine bet by not removing helium from natural gas before shipping gas to fuel markets. Soaring demand has placed helium in very short supply. Gas producers should keep their eyes open for possible helium sources, by testing the helium content of their gas. Samples sent to the U. S. helium plant at Amarillo will be analyzed free of charge. Helium brings a price of $19 per Mcf. A 1 percent content will pay out.

Good Wells Make Good News

January, 1958

ACIDIZING has long been a good way to stimulate production from zones of high solubility. With Dowell-proved addition agents, acid is giving faster payouts in more fields than ever before. Here are some recent examples of successful Dowell acid treatments.

- **Meade County, Kansas** (New Gas Well): This well was completed in the Mississippi lime (90-95 per cent soluble) at 6470 to 6494 feet. Before treatment, it tested 3.5 mmcfd open flow. *After treatment with 10,000 gallons of Retarded Acid, injected down casing at 28.5 bpm, well tested 30 mmcfd open flow.*

- **Alberta, Canada** (Old Well): This oil well was completed through two sets of perforations in the Elkton member of the Mississippian lime at about 9100 feet. Production had declined to the point where the well would flow only one or two days—then die for three or four. Dowell recommended a combination acid treatment designed to get deep penetration, using 5000 gallons of Retarded Acid ahead of 15,000 gallons of the acid-oil emulsion used in Acid Petrofrac®. The treatment was performed down casing to reduce treating pressure. Average injection rate was 6 bpm at 3300 psi. *After treatment the well tested 440 bopd flowing on three consecutive tests.*

- **Crawford County, Illinois** (New Oil Well): Completed in Aux Vases sandy lime, 1514 to 1532 feet open hole. Initial production 50 bopd. Acid Petrofrac was selected as the treatment. A 500-gallon spearhead of regular Dowell inhibited acid with surface tension reducing agents, preceded 3000 gallons of acid-oil emulsion with 3000 pounds of sand down 4½-inch casing, 12 bpm at 1400 psi. *After treatment, well was put on pump at 140 bopd—much better production than other wells in the area.*

- **Lea County, New Mexico** (New Well): This oil well would not flow when completed in the flashy Kemnitz Wolfcamp lime at 10,600 feet. Treatments performed on other wells in this field indicated regular acid would not give desired results because of the fast reaction rate of the acid with the formation. Dowell engineers recommended a combination treatment using 1000 gallons of Mud Acid, 3000 gallons of Retarded Acid and finally 15,000 gallons of the acid-oil emulsion used in Acid Petrofrac®. Since each acid has a different reaction time, this treatment was designed to extend the drainage area of the well by getting deep penetration. *After treatment the well tested 275 bopd flowing.*

Whether your well responds best to regular acid, thickened acid or an acid-oil emulsion your Dowell Engineer can tailor a treatment to the requirements of your well. For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

Services for the oil industry DOWELL

A Service Subsidiary of The Dow Chemical Company

Let's pool our research

OIL INDUSTRY RESEARCH stands on the threshold of a great error—or era—depending on which of two courses it chooses to take in future handling of fundamental data:

Course #1—The Great Error . . . Each company can go its separate way. When pieces of basic information vital to the success of a non-competitive project are needed, each research staff can make its own studies, taking the expensive chance of duplicating data already obtained by another company.

Oil industry management can nurture the naive assumption that each individual research staff, using the same measurements, can work independently and come up with precisely the same values.

The nation's top research authorities declaim this approach as a glaring error—a retardant to oil industry progress. Duplication of manpower and capital investments never have, and never will, contribute to the success of any company or industry.

Course #2—The Great Era . . . Oil companies can pool their efforts to have fundamental, non-competitive work done in one place fitted with the necessary tools for performance and review to insure faith in the accuracy and validity of the findings.

This is the purpose of the API Fundamental Research Program—to broaden the industry's foundation of basic knowledge. Since 1926, the industry has spent $7 million on this program. About 75 projects have been undertaken in the areas of occurrence and recovery of petroleum, and the composition and properties of petroleum. Since 1954, the API research program has also dealt with preliminary investigation of weather forecasting.

In production alone, API research on wettability has thrown light on the extremely complex problems concerning the manner in which various liquids, such as oil and water, behave in contact with each other and with certain solids, such as grains of sand in a producing formation. Work in geophysics has provided information which has helped develop better methods of mapping the sub-surface structure of the earth.

Of all the API projects dealing with the occurrence and recovery of oil, probably none has been more widely discussed than the study on "Fundamentals of Hydrocarbon Behavior" at California Institute of Technology. From the basic information provided by Cal-Tech, oil companies developed much of their present knowledge of retrograde condensation. It is reported that techniques developed from this knowledge have made possible the recovery of 1.7 billion barrels of oil.

The people assigned to the study called "Analysis, Purification and Properties of Petroleum Hydrocarbons" have spent 30 years on the job. Their work has cost more than $1.5 million to date. And they have isolated only 159 hydrocarbons, although that number accounts for 46 percent of the volume of a typical crude oil.

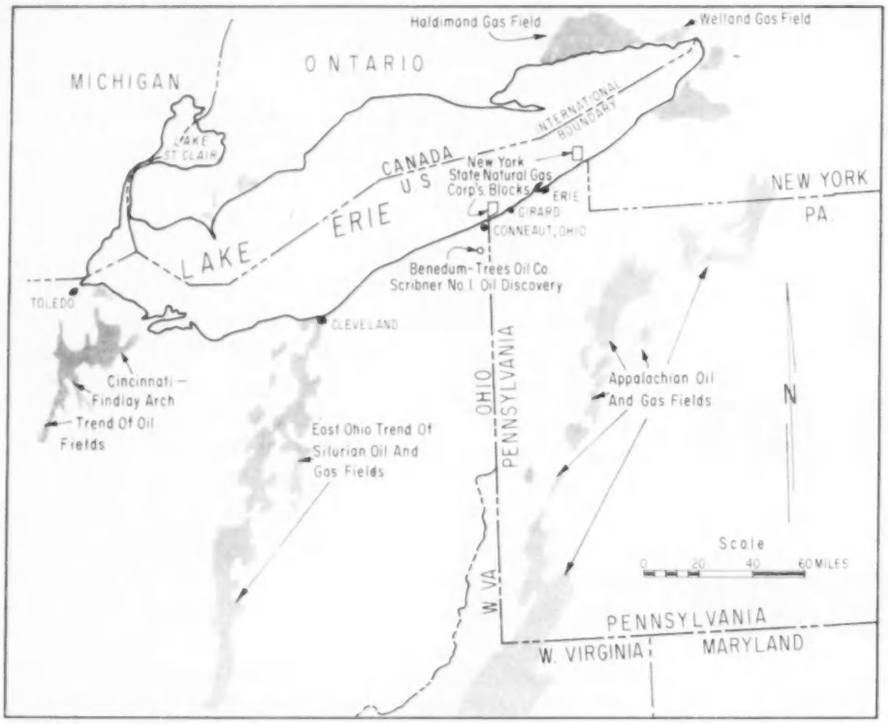
From another project, as of this year, the API research program has 257 standard samples of pure hydrocarbons—approximately 100 more than have been found in crude oil. To get some idea of the challenge ahead, it is generally agreed that there are about one million different compounds in petroleum—if, and when they can be found.

These are but a few of the basic API findings that have been made available to oil companies. There are many more problems yet to be solved, i.e., What does petroleum contain? What do we know about its ingredients? Can they be separated?

The answers to such questions must be found if the oil industry is to meet the pressures for improvement that are posed by fast growing demand for both quantity and quality in oil products. Most of the industry's improvement must be of its own creation, the product of its own research.

There is no short cut to fundamental data. But, the beauty of it is, it need be obtained only once—if it is developed through a cooperative program such as API.

Faced with rising costs and increasing hardships in finding oil, the economic strength of the U. S. oil producing industry rests on the success of scientific research. Which will it be—a great error, or a great era?



A start has been made toward possible development of U. S. offshore gas or oil production in Lake Erie. Such production would link up established U. S. and Canadian fields. Pennsylvania has granted leases on two tracts.

Offshore Oil to be Sought On U. S. Side of Lake Erie

Leasing of tracts by Pennsylvania is expected to be followed by leasing of Ohio and New York offshore areas. Drilling in lake might result in linking of U. S. fields with pools already developed in Canadian waters.

By H. T. Brundage, WORLD OIL Staff

INITIAL STEPS have been taken toward trying to develop U. S. offshore production in Lake Erie. Such production would constitute a linking up of New York and Ohio fields with trends already developed on the Canadian side of the same lake.

The first offshore tracts to be leased on the U. S. side of Lake Erie were awarded in October, 1957, to New York State Natural Gas Corporation by the Commonwealth of Pennsylvania, following submission of closed, competitive bids. A total of 35,630 acres in two tracts was leased, pursuant to a new law known as Act 293, which was passed by the Pennsylvania legislature during the 1957 session. This leasing represents only a small start toward expected widespread future granting of rights to drill in the Lake.

Legislation to enable offshore leasing in Ohio has been enacted, and implementation of the law into action is considered only a matter of time. New York State is expected to follow suit within the next two years. In both New York and Ohio, known production continues to the Lake Erie shore line and ends there only because of lack of offshore drilling. There is production both onshore and offshore in Lake Erie in Ontario, across the Lake in Canada.

Each of the Pennsylvania tracts begins half a mile offshore. Block 1 borders the Ohio section of Lake Erie, lying about eight miles northwest of Girard, Penn., and consists of 19,130 acres. Block 2, located about 15 miles northeast of Erie, Penn., within four miles of the New York part of the Lake, comprises 16,500 acres. Block 1 is considered the more prospective of the two at the present time.

Few Bids Received. The Department of Forests and Waters in Harrisburg received about 120 separate inquiries concerning tracts to be put up for leasing in Lake Erie, but was disappointed to receive only two bids on each of the two blocks offered. However, the important fact is that these blocks have been leased and will be drilled, as each lease carries an 18-month drilling obligation.

Pennsylvania's jurisdiction insofar as leasing is concerned extends to the International boundary in the middle of the Lake, which was set by treaty between the U. S. and Canada. The distance of the International boundary Varies from about 15 to 25 miles offshore from Pennsylvania. It lies almost 30 miles offshore at its maximum distance from the Ohio shoreline of Lake Erie.

Both Ohio and New York State have longer Lake Erie shorelines than Pennsylvania. Actual production ends abruptly at the shoreline in certain areas in New York and Ohio. Since drilling activity is assured offshore from Pennsylvania, it is almost certain to be allowed in the other two states within the next few years.

The deepest sounding in Lake Erie has been reported to be 210 feet, and most of it is much shallower. Hence, all of it will probably prove to be drillable, either with existing equipment and techniques, or those currently under development.

The only other company to bid on these tracts was Kewanee Oil Company, Philadelphia, Kewanee bid $6312.90 (33 cents per acre) on Block 1 and $7095 (43 cents per acre) on Block 2. Thus, Kewanee's bids aggregated $13,407.90. They were not even close to New York State Natural's bids, which amounted to $90,817.70, including $72,502.70 ($3.79 per acre) for Block 1 and $18,315.00 ($1.11 per acre) for Block 2. Kewanee apparently considered Block 2 to be slightly more prospective, judging from the price offered, whereas New York State Natural's bid for

Two offshore tracts leased by New York State Natural Gas Corporation from Pennsylvania may be drilled as early as the spring of 1958, following the annual thaw. The company is obligated to drill a test on each block within 18 months.

Block 1 was almost four times as high as the price offered for Block 2.

May Drill Next Spring. New York State Natural Gas Corporation had no immediate plans for drilling, since the winter freeze-up was too close at hand when the tracts were received. The firm's geological department expected to recommend drilling locations on the basis of known subsurface data onshore. The tracts might be drilled as early as the spring of 1958, following the thaw. It was intended that cable tools would be used. Temporary steel platforms would support the rigs.

The Pennsylvania law authorizing such offshore leasing is rather simple. In essence, it authorizes the Department of Forests and Waters to advertise and award such leases on a competitive bid basis and to "enter into agreements for the removal of oil and gas beneath the waters of Lake Erie."

The type of lease offered by the Department of Forests and Waters to cover Lake Erie operations is patterned after those covering state forests, with special adaptations intended to protect fish, water purity, natural beauty, and other aspects of the Lake in the public interest. New York Natural's leases are for a 10-year primary term, continuing thereafter so long as oil or gas is produced in paying quantities. Permission to drill within half a mile of the shoreline may be done only upon permission of the Department of Forests and Waters, to offset production along the shore. The lessee must prevent pollution of the water.

The lessee must also cooperate with the U. S. Army Corps of Engineers, in charge of navigational matters in Lake Erie, and must receive the Engineers' approval before erecting any structures, including drilling platforms, in the Lake.

Seismic work may be done after obtaining necessary permits from the Pennsylvania Fish Commission. New York State Natural indicated that there were no plans to conduct seismic operations in Lake Erie, but that they were glad to have this clause in the lease in the event they decide to conduct seismograph surveys.

Obligated to Drill. New York Natural is obligated to drill a test on each block within 18 months to or through the Ordovician Trenton Formation, unless commercial production is found at a shallower horizon and the Department waives the requirement for this reason. New York Natural's geologists believe that a 5000-foot test would penetrate the Trenton limestone, and a 5500-foot test would undoubtedly do so. Minimum development rate acceptable to the Department in the event of production would be one completed well during each lease year.

The closest allowable spacing for gas production is set at 80 acres per well, and for oil, 20 acres per well. The lessee must pay royalty to the Department at the rate of ⅛ the value of oil, gas, and condensate produced. Methods of measuring gas production are very specifically defined in the lease.

Annual rentals apply, payable in advance each year; but for the completion of each well to or through the Trenton Formation or shallower depths if productive, 200 acres may be deducted from the acreage subject to rentals payments.

Casing Program. In the case of Oriskany sandstone tests, the operator must set pipe in the Onondaga limestone and cement it to 500 feet above casing seat. Heavy gas flows from the Oriskany are fairly common, and if pipe is not run above the Oriskany, physical waste and fire hazards exist if gas is found therein, and casing and/or tubing must be run after gas is encountered.

Producing wells are to be completed and connected to pipe lines as near as practical to the lake bottom, and marked by buoys of types approved by the U. S. Coast Guard. This will no doubt prove expensive, not only in the case of christmas trees in the event gas production is found, but particularly in the case of pumper oil production. However, such submarine completions will be essential, not only for navigational reasons, but primarily because the heavy winter freeze-ups would cause heavy damage to any permanent platforms erected. The depths of water recorded vary down to about 60 feet on Block 1, and to as deep as 120 feet on Block 2.

The lessee is obligated to post a surety bond of $75,000 with the Department. On completion of the first Trenton test or a commercial well, the bond is reduced to $40,000.

Among other interesting clauses, the lessee agrees that if the lease is offset by blocks on which oil and gas rights are leased to other parties, the lessee will attempt to enter into unitization agreements with the offset leaseholders to prevent drilling of an excessive number of wells. Though there is no compulsory unitization in Pennsylvania, the Department thus puts itself on record as favoring unitization when all interested parties will agree to it.

Prospective Formation. The lower Paleozoic section to be penetrated by the tests New York Natural is obligated to drill is considered prospective in a number of horizons. The Oriskany sandstone (basal Devonian) pinches out northwestward along a trend roughly parallel to the Lake Erie south shore, and thus may be entirely missing under these tracts. However, it is quite possible that the Oriskany feather edge may swing northward under the Lake, particularly under Block 1. The Sylvania sandstone of Ontario is considered to be correlative with the Oriskany, and the Sylvania is considered prospective in some areas in Canada where it occurs. The Guelph-Lockport dolomite formation (Silurian) bears watching, particularly for reefing that may develop. Among other lower Silurian formations, the Red Medina (Grimsby) and White Medina (Whirlpool) sandstones are prospective. The Trenton limestone (Ordovician) has already been mentioned. The Trenton is not generally expected to be dolomitized this far east. Some geologists think that the Gatesburg sandstone (upper Cambrian) may

have possibilities in the Lake Erie area.

Pre-Oriskany possibilities of the northern Pennsylvania-Ohio border area have been recently emphasized by an important oil discovery near Conneaut, Ohio. On September 20, 1957, Benedum-Trees Oil Company's Scribner 1, located in Monroe Township, Ashtabula County, 3½ miles west of the Pennsylvania boundary and about 10 miles inland from Lake Erie, was completed for 150 barrels of 42-gravity oil per day on a ¼-inch choke. Perforations were between 3292-3340 feet in Red Medina. The well was fracture-treated and was said to be capable of much greater production on bigger chokes. It was drilled with cable tools and was completed flowing by heads through seven-inch casing. The crude was of mixed base, and reported to be Corning grade. Gas-oil ratio was estimated at 650 to one. Over 100 feet of Red Medina was drilled, and 50 feet of it was reported heavily oil-saturated, with no water. Nearest production from the Medina or "Clinton" sands is in Ohio, 84 miles distant. Benedum-Trees had a 12,000-acre block surrounding the Scribner well and was planning rapid development. The new discovery emphasized the contention that pre-Devonian possibilities in the Lake Erie south shore area have been largely ignored.

Ohio Prospects Good. In Ohio, the agency with jurisdiction for granting leases in Lake Erie will be the Division of Shore Erosion, located in Columbus. Leases, when issued, will have a primary term of up to ten years. Extension northward into Lake Erie of a trend of Silurian oil and gas production that runs north-south through most of eastern Ohio would seem virtually assured if Ohio would proceed with offshore leasing north of Cuyahoga and Lorain counties, in the Cleveland vicinity.

In extreme northwestern Ohio bordering Michigan, it might be possible to extend the Trenton production trend northward from the Cincinnati-Findlay Arch, if state leasing were effected offshore from Ottawa and Lucas counties in the vicinity of Toledo. —**The End**

Check List Assures Good Report for Seeking Loan

• Certain information is required by banks in making loans on oil and gas properties.

• Operator can supply needed data in complete and satisfactory form by following outline suggested here.

By C. R. Dodson
Assistant Vice President
Petroleum Department
The First National City Bank of New York, N. Y.

BANKS ARE just as anxious to make loans to oil and gas producers as the latter are to obtain them. It is good business for both parties and has greatly contributed to the development of this dynamic industry.

But in order to make an intelligent and business-like decision the bank must have complete information concerning the property upon which a loan is to be made.

Oil loans are based on oil and gas reserves. The reserves cannot be "seen" and counted or insured, and the future production or income cannot be estimated from past statements of assets, liabilities, income, and expenses. Therefore, reports of petroleum engineers experienced in reserves estimated and forecasts of production are required.

Reports submitted to banks have shown a wide range in content and presentation. Some are satisfactory, others are almost worthless to a bank. The majority are partially useful but require much additional work and checking by the bank.

Unfortunate experiences with reports are so numerous, particularly as to omissions of items important to banks, that The First National City Bank of New York made a study of reports in its files and prepared a checklist or outline showing the information and material needed to make a report complete and satisfactory.

The checklist as prepared by the bank is presented here with the thought that it might be of service to petroleum consultants in preparing their reports for bank loans and thus help their clients to obtain such loans.

The checklist is divided into four categories:

I. Letter of Transmittal with Dates.
II. Summary of Results.
III. Discussion.
IV. Exhibits.

The letter of transmittal is usually

brief, but it should establish the authorization for the report, for whom prepared, the pertinent dates, resume of results and certification.

The summary of results should show in outline and tabular form, reserve estimates, forecasts of production and income, the properties and appropriate references to other tables and exhibits in the report. If the report covers valuation or fair market values they should be included here.

The discussion is the body of the report and must be supported by the details and maps. These may be presented as follows, or the following headings and items could serve as a checklist for preparation of a report to insure completeness:

A. Producing Properties.

1. Location, Description, Interests Owned, Any Special Lease Conditions or Expirations, Field Inspections and Tests.

2. Development to Date.
   a. Wells, coring and tests, completion data.
   b. Subsurface geology.
   c. Producing formations.

3. Laboratory data.
   a. Core analyses.
   b. Fluid analyses.
   c. Model studies.
   d. Special laboratory tests.

4. Production History, Tables and Curves showing:
   a. Oil, gas, gasoline and LPG water and ratios, (sand if any), field tests and certificates.
   b. Pressures,
      i. Wellhead,
      ii. Separators,
      iii. Bottom hole (static, flowing and build-up).
   c. Dehydration and waste water disposal.
   d. Repairs, redrills.
   e. Remedial work, (acid, fracturing, etc.).
   f. Potential tests.
   g. Allowables, M.E.R.'s Reports on hearings.
   h. Injection or cycling by gas or water.
   i. Offset operations.
   j. Unit or cooperative programs in operation or pilot stage.

5. Maps.
   a. Property or leases.
   b. Structure.
   c. Cross-sections (correlated electric logs).
   d. Isopachs (gross or net pay).
   e. Isobaric.
   f. Miscellaneous—Water influx, gas cap expansion, gas-oil ratio, iso-vol, iso-perm, etc.

6. Operating costs, including severance and ad valorem taxes (note source and history of data).
   a. Flowing, pumping, dehydration, water disposal.
   b. Pro-rata costs, overhead, administration.

7. Transportation costs if borne by production.

B. Forecasts of future production by calendar years, usually 10 years, but up to 15 years for some loans. (Tables and curves accompanied by adequate explanations).

1. Production of oil, gas, water, gasoline and LPG (sand if any) wax and corrosion products, H_2S.
   a. Allowables or restrictions used.
   b. Capacity operations, pumps, (sizes), gas lift.
   c. Engineering data and analyses on:
      i. Pressure and Productivity index (forecasts).
      ii. Economic Limits (basis).
      iii. Completion and recompletion work to maintain production.
   d. Net production to subject interests exclusive of oil payments, royalties, overrides, carried interests, etc.
   e. Ultimate future production.

2. Income to subject interests from sales of production.
   a. Gross income.
      i. Posted prices and/or contracts and escalation clauses.
   b. Costs including severance and ad valorem taxes attributable to subject interests.
      i. Field expenses.
      ii. Overhead and General Administration.
      iii. Development, future required or optional.
      iv. Rework and deepening programs.
   c. Net income.

C. Reserves, gross and net to subject interests as of report date (prove only) expressed as barrels, Mcf. Gallons, percent of total and per acre foot.

1. Oil, gas, gasoline and LPG.
   a. Developed and producing.
   b. Developed and non-producing.
   c. Proven non-developed.

2. Bases for reserve estimates.
   a. Volumetric (san count).
   b. Decline and performance curves.
   c. Comparison to similar production in other areas.
   d. Material balance or other equations and charts.
   e. Model studies and laboratory tests.
   f. Well data and tests.
   g. Electric logs.
   h. Core analyses.

3. Factors affecting reserve estimates.
   a. Data limitations and sources.
   b. Performance history.
   c. Well damage by corrosion or other causes.
   d. Frac or acid experience.
   e. State regulatory actions and penalties.
   f. Field operations, equipment or management.

4. Production programs.
   a. Fluid injection.
   b. Production and pressure control to obtain maximum benefits from water influx, gas caps and/or gravity damage.

D. Miscellaneous and pertinent data or information felt to have a bearing on the reserves or forecasts.

It is strongly emphasized that the major portion of the above data should be compiled and presented in tabular form, with suitable remarks or footnotes, such as, upper and lower limits of estimates if any, assumptions used, references to comparable situations, etc. —**The End**

Staff Report

Do You Measure Decisions?

THE PRINCIPAL VALUE of "Operations Research" and the other management sciences lies in making available to management better measurement of the variables under management's control. The management sciences provide useful *yardsticks for management* where hunch, intuition, trial and error, and other expedients have been used in the past.

This is not to suggest that management has had no yardsticks. If anything there have been too many, usually with dollar marks instead of inches, but usually with different dollars as the basis for the marks on the various yardsticks.

An example may clarify the point: A major producing company expressed grave concern about the "high" cost of maintaining its production; it was using a dollar yardstick on which the intervals were out-of-pocket dollars (the kind that always hurt most). If this were a "closed" problem and the out-of-pocket dollar measure were valid, the obvious solution to the problem would be to stop maintaining the fields! Obviously, this is no solution.

But a solution begins to emerge when maintenance dollars are looked at as investment dollars from which a maximum return is expected. Before the maximum return can be computed, the critical variables in the system must also be measured: What is the best rate of field development in terms of the associated maintenance problem? What is the effect of the increasing age of the producing wells on maintenance requirements? What is the effect of developing more and more remote areas as the readily accessible areas are worked out and abandoned? If an increase or decrease in maintenance equipment is indicated by the analysis, what units should be acquired or retired? Are technical personnel available for expansion of the maintenance effort, if this is indicated? These are just a few of the questions that must be answered before management has at hand a yardstick that states accurately whether or not the maximum return is being realized on currently allocated maintenance dollars—or whether the current allocation should be increased or decreased *and by how much.*

It is interesting to note, parenthetically, that many analyses which started because of someone's interest in "cost reduction" (usually in the maintenance and inventory areas) end up in recommendations to increase the investment in maintenance or inventory, as the case may be. For just as the wrong yardstick (out-of-pocket dollars) is usually used where maintenance is concerned, other wrong yardsticks are used for inventory. Thus, carrying costs or obsolescense costs usually loom large in a manager's eyes, frequently to the exclusion of the high costs of the increasingly frequent setups that become necessary as inventory is reduced.

If your answer is 'No', then this description of a money-making yardstick for decision makers is for you.

Operations Research Method. How do the management sciences go about providing better answers more quickly?

Perhaps the following description of the systematic approach used in an Operations Research study will help answer this question.

Preliminary Look. The usual first step in conducting an Operations Research study is to observe the system or operation as it is operating. For a new group or team this is, of course, essential, but even a group or team that has been working in an organization for some time must "review" occasionally, especially before starting on a new kind of problem.

Observation of the physical operations is *necessary* to a preliminary understanding, but a very careful look at the flow of information is essential

—for decisions are based on information and are themselves an input to the information system. Hence, information flow is all important.

A very effective device is to lay out the information flow and materials flow on an actual plan of the facility in which the operation is being conducted. Such a layout frequently reveals anomalies that have "just growed" and can be corrected quite easily to the benefit of the whole organization. For example, two offices which exchange considerable amounts of information may have become separated because of space requirements—without considering the delays resulting from such separation.

Once the flow of information, and its relationship to the physical operation, is understood, specific problems of information flow, process control, inventory control, and the like begin to appear. This provides a rational basis for a meeting with management in order to select the problem area that will get first priority.

Formulating the Problem. By the time of the management meeting, the research team will have a good idea of the probable payoff to be obtained from the solution of the several problems. It will also have a good idea of the time and effort that will be required for a solution. More important, it will have had a chance to discuss objectives with management so that a suitable *measure of effectiveness* can have been developed. This will usually be a least cost or maximum profitability measure, but it will be subject to restrictions like stable employment or relations with labor or the community.

In the meeting with management, various assumptions may be agreed upon. These are necessary as a means of reducing the problem to manageable proportions, but they are also necessary to agreement on objectives. The need for additional, more detailed assumptions will arise as the research proceeds—and even the initial assumptions may have to be changed.

The most important element in formulating the problem is the determination of genuine cause-effect relationships. A company may be convinced that its market is changing, and may demand a marketing study, when its real problem is that its own technology has failed to keep pace. Or it may have the very latest equipment, but may be using it exactly as it used its older equipment, wondering the while why costs are going up so rapidly. The basic objective of the Operations Researcher is essentially the same as that of the medical practitioner: He wants to get at causes; he does not want to treat symptoms.

Developing the Model. The next step is to develop a model of the system under study. This may be verbal, at first, or it may be graphic or even mechanical, but it soon becomes a mathematical model because of the greater ease with which a mathematical model may be manipulated. In all cases, it will seek out the variables under the control of the client, the variables that he does not control, and the constants (actual or by assumption) in the system. And these are all related to the measure of effectiveness. Most models start out quite complex, but most of the complexity is eliminated by making reasonable assumptions about the non-controllable variables, thus reducing the required manipulation to that concerned with the controllable variables.

In some cases, the model will yield to direct analytic solution. Often only numerical solution or iterative processes can be used because of the complexities involved (or because of the inadequacy of existing analytical techniques).

Techniques. It is in connection with model construction and solution that the greatest misunderstanding about Operations Research has developed. Most of the articles that have appeared on Operations Research are general in nature or they deal with *techniques* of solution of various models. The result is that most people get the idea that Operations Research is some unexplainable brand of hocus-pocus because the general articles usually say too little about too much; or they get the idea that Operations Research is a branch of mathematics, if only because the articles on technique can become mighty technical.

Actually, the mathematics used in Operations Research seldom gets beyond basic calculus, fairly elementary statistics, probability theory, and some matrix algebra. Of these, the probability and statistics are probably most important in terms of frequency of use, although matrix algebra receives quite a play because of linear programming.

The basic models are relatively few, but the variations (to adapt the models to particular problems) are practically unlimited in number. The greatest development has come in connection with waiting lines (queues) such as develop when "customers" (parts to be processed, aircraft to be landed, diners to be served, etc.) require service at some facility. Next in state of development is the work on production and inventory control. Problems of maintenance and replacement, sequencing of operations, and allocation of resources to various activities have also had considerable attention and appropriate models have been developed.

Much work is currently going forward on integrated information-handling systems, on programming of research and development, and analysis of competitive systems, to name a few areas, but little of this work has reached the "guaranteed payoff" stage. Some attempts have been made at over-all synthesis of the operations of an entire company, but few of these attempts have as yet been successful, primarily because so few Operations Research groups now working in industry have been in business long enough to have done the necessary background work to make such synthesis possible.

Testing the Model. Once the model has been developed and solved, it must be tested, and data-gathering begins. Up to this point there has been, of course, some data-gathering, but it has been incidental, or should have been. For the model also provides a clear specification of the data required for the solution of the problem.

Once the data have been gathered and reduced, the model is "worked," using the live data from the system under study. If this manipulation produces results that differ from those actually obtained, the model is inadequate or defective and the research must be recycled through model development. Only when the model reflects the existing operation can it be considered adequate.

Then the controllable variables may be altered in order to determine the effects of change in these variables in terms of the measure of effectiveness. In this way a solution is reached.

Testing and Controlling the Solution. But the solution thus reached is a solution only if the assumptions that have been made are valid. Thus it becomes necessary to consider alternate

assumptions (at least those to which the solution is sensitive). The solution may prove valid over a wide range of assumptions or it may prove so sensitive to one or more assumptions that the researcher comes up with alternatives among which management may choose.

Even then, the task is not complete. Suppose that management chooses a course of action based on one assumption or set of assumptions. Then the researcher must also provide management with control limits within which the solution remains valid. If demand, or labor costs, or any other element about which assumptions have been made changes outside these control limits, management will require a new solution—or may even have a whole new problem.

Implementation. Throughout the process just described, the results are being implemented, in the sense that both management and the operating people involved are kept informed (whether formally or informally) as the study progresses.

Management must provide guidance and access to information. Operators must understand what is going on and changes that are to be made, must be within their capability to handle. Frequently, minor procedural changes can or must be made as the study progresses, either to remove obvious anomalies or to obtain needed data. In this way, the entire study is conducted in an atmosphere most likely to ready acceptance of the required changes when they are effected.

It should be pointed out in this connection that change *is* involved. And change frequently engenders resistance at one or more points up and down the line.

Because the Operations Researcher has a constant concern with the problem of implementation (in other words, he is concerned with affecting the real world and is not interested in the mere accumulation of knowledge about the real world), he can usually reduce resistance to change as he goes along. This can—and perhaps should—extend to personnel changes in terms of including such organizational changes as will absorb "displaced" personnel.

For this reason, gradual implementation is frequently a recommendation so that the organizational impact is distributed over time.

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

Is It Easy to Find Oil?

New oil fields are getting harder to find every year. And the cost to develop new reserves is increasing rapidly. In fact, one famous geologist said: "Today, the best place to find oil is in your head," and there's at least 100 billion barrels of bonus oil in the U. S. to prove it. Using all the most modern research techniques and equipment available, oil men "found" this oil by thinking out more efficient means of water-chasing reluctant oil out of old or sluggish fields. Generally, it takes from 10 to 15 barrels of water to flush out one barrel of oil. Finding new methods for recovering additional oil from underground costs the industry millions of dollars every year—but it is one way in which the nation's needs can be met.

Is It Expensive to Drill for Oil?

To give an example, the following product accounts for a small fraction of the total drilling costs. It's name is mud. But far from being common dirt, this fluid so vital for oil well drilling is a scientific blend of special materials which can cost as much as a dollar a pound. Tailor-made chemicals, caustic soda, corn starch, redwood fiber, shredded cellophane, walnut shells, chicken feathers, and any number of other strange materials are added to "mud" to solve drilling problems, such as caving, or controlling gas pressures. Oil wells consume $100 million worth of mud every year—840 gallons every drilling minute!

How Does the Oil Industry Finance Its Operations?

A growing America needs oil—39 billion barrels of it in a ten year period between 1956 and 1965. This is the equivalent of 80 percent of all the crude oil produced in the 98-year history of the domestic oil industry. Finding the oil and bringing it to market will cost a staggering $73.5 billion. Main problem facing the industry is where to find the money. About $44.5 billion may be available from provisions covering the cost of replacing facilities that are wearing out, such as percentage depletion and charges for depreciation. Another $18.5 billion must come from the earnings of oil companies. The remaining $10.5 billion will have to be borrowed from the savings of small investors all over the country. Far from being "money in the bank," these funds will depend on whether the oil man can make a fair enough profit to provide the incentive for others to invest in his business.

we can show you the forest because of the trees

Many times oil men feel they are in a poor position financially simply because they can't see the entire picture of their operations. Caught in the complexities of their day-to-day activities, they are unable to survey their properties in a realistic, objective manner. And as a result, many times they end up working for their creditors.

Increased operating costs spell falling profits. And that means trouble. While there is no short cut way out of this problem, The Commerce working with your legal and tax counsel can many times show you how to increase profit by reducing costs. Tighter managerial control, an analysis of costs, and recommendations for changes have increased the profit of other oil men. If your problems are similar, come to the bank that actually does know the oil business and that can help you.

E. O. Buck, vice president, Oil Loan Department

Member Federal Deposit Insurance Corporation

THE NATIONAL BANK OF

COMMERCE

Gulf Building, Houston, Texas **OF HOUSTON**

Facilities of The National Bank of Commerce Oil Loan Department are available in Wyoming, Nebraska, Colorado, New Mexico, Texas, Louisiana, and Mississippi.

Here is What Oil Men Say . . .

Twenty-four hours a day, around the world, oil men are using COMPOSITE CATALOG. Shown below are a few comments* (typical of thousands received) from oil men in every oil producing country of the world:

"This catalog is used daily by our staff in ordering replacement parts and new equipment."—Drilling Foreman.

* * *

"Engineering and purchasing would have a hard time without it."—Production Engineer.

* * *

"Your Composite Catalogs are and have been very useful to me on both foreign assignments and present job."—Drilling Superintendent.

* * *

"It is of considerable value to me as a ready and constant reference to equipment available."—Division Production Superintendent.

* * *

"I can never thank you enough for the many hours your Composite Catalog has saved me."—Chief Engineer.

* * *

"When listed in Composite Catalog, information is at your fingertips. Separate bulletins are hard to find."—Production Engineer.

* * *

"Composite Catalog is a very important asset. It would take hours to keep separate bulletins in order."—Vice President.

* * *

"You have the most useful piece of literature in the drilling-producing section of the industry."—Division Engineer.

* * *

"I have been using the Composite Catalog for 25 years and find it very satisfactory."—Production Superintendent.

* * *

"We use our Composite Catalog to check all new improvements—to compare equipment before a purchase."—Drilling Contractor.

* * *

* Originals in all cases are on file in Gulf Publishing Company's Houston office.

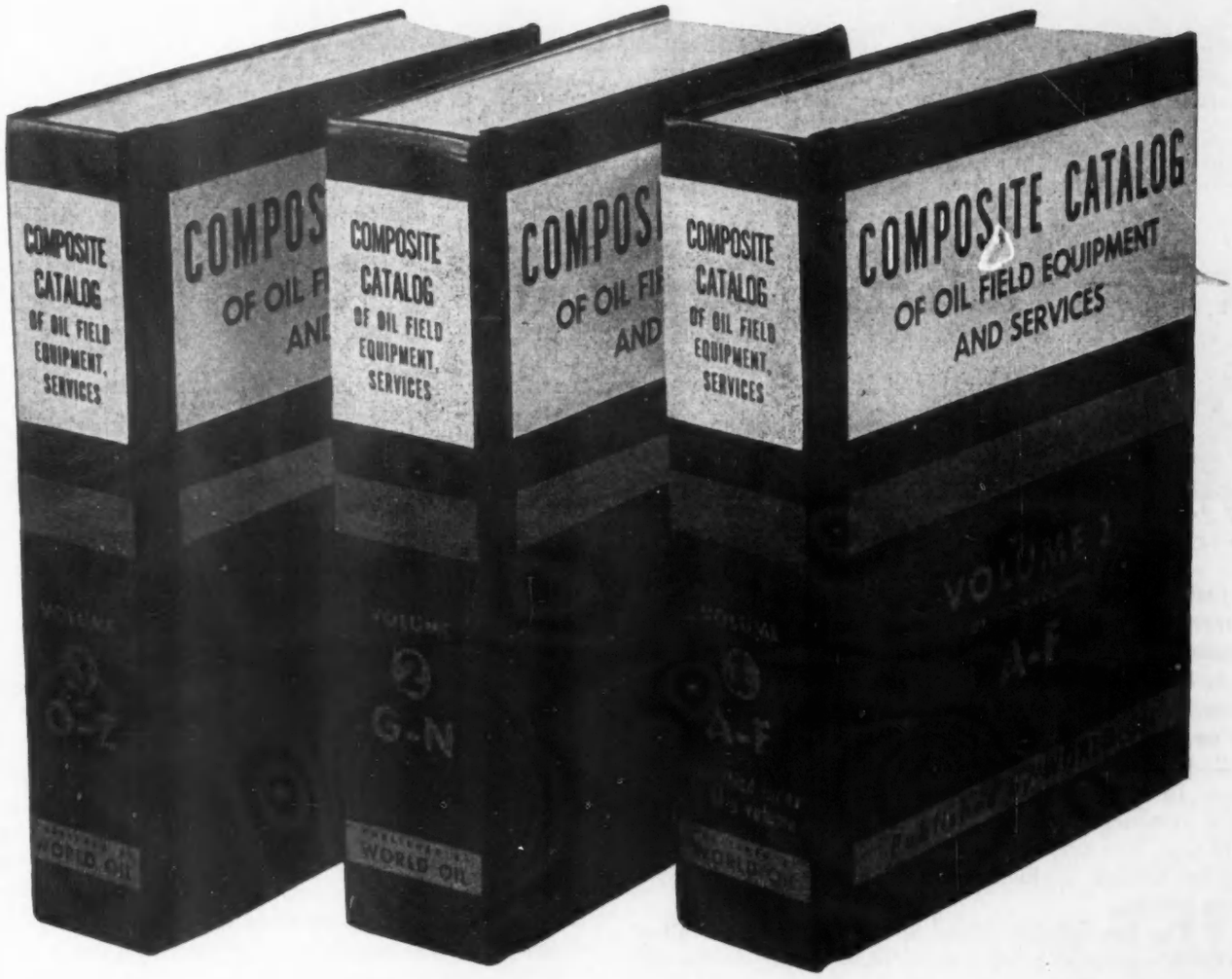
When You're Ready to Buy:

LOOK FIRST IN COMPOSITE CATALOG

The current (22nd) COMPOSITE CATALOG is by far the most complete compilation of data ever published on oil field equipment and services.

Its three volumes contain the complete or condensed catalogs of more than 500 leading manufacturers and service companies serving this worldwide industry. In this edition you'll find detailed information on more than 3,000 oil field products and services—all completely indexed and cross indexed for quick, convenient usage.

There is nothing else like the COMPOSITE CATALOG for the oil and gas exploration, drilling and producing industry.



THE COMPOSITE CATALOG

OF OIL FIELD EQUIPMENT AND SERVICES • PUBLISHED BY WORLD OIL

P. O. Box 2608 **Houston, Texas**

The white elephant being studied by the author (right) and a Socony-Mobil official is the key figure in a novel safety promotion idea. At first, "Whitie" is made the unwelcome property of the department head whose operation has the poorest accident record during a given month. If no department has an accident during the month he is placed on the supervisor's desk. When no accidents occur for a year he is put to rest on the director's desk. If a plant or department has no accidents for two years "Whitie" is shunted off to the elephants' graveyard.

Keys to Effective Accident Control

Here are the ingredients you need to organize a successful safety and fire protection program in your operation.

By J. L. Risinger
Safety and Fire Protection Consultant, Maplewood, N. J.

ORGANIZATION OF fire protection programs are closely integrated with accident prevention for the following reasons:

1. Failure in fire prevention or fire control often results in explosion or fire that results in injury or death to people as well as damage to property.

2. Human failure is the chief cause of accidents and fires. In many cases the same type of human error is most conducive to the cause of either or both injury and fire. The prevalence of this factor in the oil industry has brought accident and fire prevention into a common ground.

3. The fire fighting phase of fire protection is allied to the fire protection engineering phase of prevention and control.

Whether the safety department is designated as carrying fire protection makes no difference—it cannot escape the responsibility of providing a service that will tend to reduce the frequency of serious injury to employes from failure to prevent fires and explosions. The prevailing policy among oil companies is to integrate all phases of fire protection with safety.

Safety Starts at the Top. In the fitting or adjusting of a safety program into the scope of organization, purposes and objectives of a company, it is fundamentally imperative that:

1. Company executives recognize the importance and vital necessity of a definite and effective organization of the safety department; that its objectives are well defined and its channels of procedure are kept open.

2. The safety supervisor is influential enough for his ideas to merit the consideration of senior executives in their planning; that he be tactful enough to cause the correction of hazards specifically and the adherence to standards of safe practices in general, without friction; that he be thorough enough to be correct in detail and not lose his sense of proportion to the extent of over emphasizing non-essentials.

3. The safety organization must function effectively with service departments, planning agencies and operating departments, so that safety links its way into and through every activity of the company from the chief executive on down.

Studies reveal that the best results are obtained when accident and fire prevention are organized in a manner to place definite responsibility on specialists without re-

The Most Important Difference is Down Inside

Differences *do* exist in circular steel blanks. We don't mean variations in size, thickness, etc.; we mean the differences in quality that are rarely apparent from mere surface inspection.

For years Bethlehem has made circular blanks by a method that both *forges* and *rolls* the steel in a single operation. Is this of any interest to the user? Does it bring about differences that are really important?

The answer is a big, emphatic yes! Bethlehem's unique method of manufacture insures such advantages as soundness, excellent grain flow, and very high strength. Because of these characteristics, the machinist can always do his job with complete confidence; there are no hidden flaws to snag the cutting tool, slow the work, or cause rejections.

If you build machinery that requires circular steel parts, especially parts for heavy-duty service, we strongly recommend Bethlehem blanks. They are suitable for such a long list of applications—flywheels, sheave and crane wheels, gears, turbine rotors, clutch drums, brake wheels, and many others. The blanks range in size from 10 to 46 in. OD, and they can be furnished heat-treated or untreated. Prices are fully competitive.

Write for a free copy of Booklet 216. Its numerous pictures and clearly written text will answer many questions that may occur to you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

lieving supervisors of their responsibilities for carrying it as a part of every operation, procedure and activy.

"Authority" vs. "Leeway." It is to be kept in mind that the safety department is a planning and coordinating agency, designed to cause the carrying of the safety ideas into every fabric of the organization. Many safety men cannot or do not get the difference between authority and leeway.

As authority is increased, responsibilities are increased. As the safety man's responsibilities are increased, it is the tendency of line supervision to get out from under, and thumb the entire job over to the safety man. Even worse, there is a tendency among some safety men to accept the responsibility, rather than push it back where it belongs.

When management and supervision reach the stage where they recognize these inequities in safety responsibility—and do something about them—a downward trend in accident rates will be in the offing.

Regardless of the placement of the safety department in an organization, to be effective the leader must be given leeway to maintain an identity and to work freely with those who are to accept plans, carry the plans into execution, plan their own work and, in short, put accident and fire prevention into successful operation.

The Safety Team. This simply means the organization of personnel, skills and facilities toward a common objective as a responsibility of each person involved. To properly reach this objective, the safety specialist should sparkplug the enlistment of all members of management,

HOW ONE COMPANY ORGANIZED A SUCCESSFUL SAFETY PROGRAM

(The following outline guided the Socony-Mobil Oil Company in setting up safety programs for its domestic and international operations.)

Planning Starts at the Top

After careful study by the board of directors, managers of the departments and special members of their staffs are called together for the purpose of establishing a well defined safety and fire protection organization and program. The following items are of first consideration:

1. The institution of reports and records.
2. Definition of duties of the coordinating office (safety department).
3. Definition and promulgation of safety and fire protection policy and channels of responsibility. These should be publicized by the president or general manager of the company.
4. Institution of recognition and incentive plans.
5. Safety, fire protection and first aid training.
6. Definition of plans for participation by all members of management.
7. Correct organization of the safety department to be of greatest assistance to management.
8. Placement of the safety organization at a level indicative of the importance of the program.
9. Organization of a safety team that will obtain the greatest benefit from the skills and facilities available.
10. Establishment of an approach that will emphasize assistance, rather than policing.
11. Organization of management and workmen advisory committees.
12. Organization of fire protection engineering groups and committees.

The management group will reconvene from time to time to receive reports of progress from department managers, and give consideration to other phases of the program.

Establish Functions of the Safety Supervisor

The status of a central safety man of a company or division is no longer that of an inspector and/or doer of safety and fire protection. He is an assistant and advisor to the manager and supervisor of the respective departments, coordinator of the program in the various departments, the provider of information on progress of the entire program and the general promoter of the program. This work is done under the guidance of the manager or director to whom he reports. When working in a department, he is working for and under the approval of the manager of the respective department, the responsibility for which is that of each department manager.

The assistance which this man can give, and the soundness of his advice will depend upon his background, training, experience, ability to plan, coordination and cooperative ability in serving managers, and ability and willingness to make the balls for managements to throw.

Many good safety and fire protection programs have failed because safety men took the responsibility off the managers, superintendents and supervisors.

Outline Extent of Executive Participation

The most effective safety and fire protection programs have been those sponsored by top executives, who let it be known by word and action that they consider the safety of employes of first importance. Following are suggestions for executives:

1. Top executives and managers can add greatly to the acceptance of the program if they will make it a point to include safety in all meetings and by mentioning it in all talks to groups.
2. Letters of congratulations and/or presentation of awards by top executives to employes with outstanding safety records are effective promotional measures.
3. The safety and fire protection program of the entire company is the program of the president and general manager, and should be one of which they are proud. The program of each department is likewise that of the manager of the department.

Put the Program Into Action

1. After the original safety and fire protection meeting, each manager should institute the program in his department and place upon each supervisor the responsibility for safety and fire protection commensurate with the scope of the job of each.
2. Using the forms provided by the central records department, the manager should proceed to institute a reporting system and records for his department, i.e., current injury, accident and fire reports; monthly disabling injury reports; monthly motor vehicle accident reports.

All reports should be cleared through the department manager's office and sent by him to the central safety and fire protection coordinating office for compilation into reports for the entire company. He should keep the president and general manager informed on the occurrence of major accidents and fires in his department.

3. The manager of the department should set up committees at his plants and/or other operations to enlist individual participation in the program.
4. He should institute safety and fire protection inspections by himself when in the field, by his engineers and other members of his staff as suited to his operations. The safety man of the company should participate in these inspections when requested to do so by the manager of the department. If reports of the inspection are made they should be sent to the manager of the department.
5. The department manager should plan and institute a training program in safety and fire protection for his staff and supervisors, and provide such aid as is necessary to supervisors in carrying this training to employes in the plants. The central safety man should assist in this training if desired by the manager of the department, and in a manner as indicated by the manager of the department.
6. When records are instituted, the manager should enter his operations in safety contests.
7. The department manager and his staff should work with other departments to establish a study of fire extinguishing equipment for the purpose of providing the most suited and effective extinguishers at the lowest possible cost.

both line and staff, into an acceptance of responsibility all along the line.

Under this policy, the president is responsible for the success of safety and fire protection in the company. The director is responsible for his department, the manager for his plant, the foreman for his group and the gang leader for those under his supervision.

Service department heads, engineers, industrial and public relations personnel are responsible for safety in their work and to exemplify it in contacts commensurate with the company's policy.

Use the Right Approach. Not too many years ago a few safety men and members of top management reached the conclusion that the past approach was wrong, that safety and fire protection was not purely mechanical but chiefly a human control factor. They agreed that both the human and the mechanical aspects of safety were a responsibility of management, both at the head office and in the field, and that the service department or staff was not only responsible to establish safety in its own department, but to make safety a part of each service rendered.

They further agreed that the safety man's job should not be purely that of an inspector, but instead he should organize the team, sparkplug the program, and assist management from the president to the supervisor in carrying out each respective safety and fire protection program.

Attitude of Executive Management. Attitude of executives and managers is the only guide to the importance a company places on any function. It has been found that more of it is required in the success of safety and fire protection than in any other phase of the company's business.

When the president and other executives include safety in their speeches and individual contact, personally reward individuals with outstanding safety records then the company will be setting into motion the type of attitude that will do more toward reducing accidents and fires than can be done by many safety men crying in the wilderness.

It is truly said that good public relations is simply putting your house in order and inviting the public to look at it. Likewise, it is not only necessary for members of management to have quality and quantity of correct attitude toward safety, but they must effectively reveal it if results are to be obtained.

By quality of correct attitude, we mean that which motivates the executive to place safety and fire protection at an effective level in his organization and to lead it in a manner to obtain the desired results. By quantity of correct attitude, we mean enough of it to reveal to every supervisor and workman that the executive wants the safety job done and believes it can be done to such an extent that he expects it to be done.

Attitude of Safety and Fire Protection Heads. This factor may not have been given before as a means of obtaining and maintaining a successful safety program. However, there have been many instances where the proper attitude and philosophy of the safety man saved the day. On the other hand, the incorrest attitude of the safety man will invariably wreck the results of any well planned safety program.

It is sometimes difficult to determine which is more valuable in a safety director—engineering ability, ability to deal with people, college training in safety engineering or experience in the school of hard knocks. Not one of these is of any value unless at least one of the others is developed. And all fall short unless the safety supervisor has, or has caused to develop, that trait which causes those with whom he deals to enjoy his associations and want to do the job of safety not as he demands, but as he helps and leads them to do it. This trait may be defined as a combination of both attitude and technique of approach.

The supervisor is still somewhat prone to assume the attitude of, "Oh that's the safety man's job." In their anxiety to do a good job, some safety supervisors have been prone to accept this attitude and before long find themselves attempting to do all the safety work instead of organizing and leading the safety team. The correct attitude of causing safety to be done, rather than a high powered attitude on the part of the safety man begets correct attitudes on the part of others concerned.

Provision of Reports and Records. Accident statistics are developed to prevent accidents. They do this in several ways i.e., they measure the need for greater safety effort, evaluate the effectiveness of safety work and can be used to reveal and credit outstanding safety accomplishments. Some promotional ideas include:

1. A simple board at the entrance to the property or in the ship, stating, "This plant has worked (blank) days without a disabling injury," will serve as a constant stimulus if changed each day.

2. Based on available statistics, the standing of each section or plant of a refinery or other operation can be published in a manner to stimulate competition.

3. Establish a certificate of merit plan. The incentive provided from an award program will do much to improve employe attitude and interest, particularly if presentations are made by the president or other top company official. The certificates can be awarded on any level—plants, divisions, departments, foremen's groups or groups of vehicle drivers.

4. Posters are effective if used properly. A poor system of change of posters, unattractive boards or poor selection of posters may detract from a safety program.

5. **The "White Elephant" plan.** (See Figure 1). This idea has been used with great success at many locations. A white toy elephant is placed on the desk of the department head whose operations had the poorest accident record during the preceding month.

When no department has an accident during the month "Whitie" goes to the supervisor's desk. When no accidents occur for a year in the entire plant he is put to rest on the manufacturing director's desk.

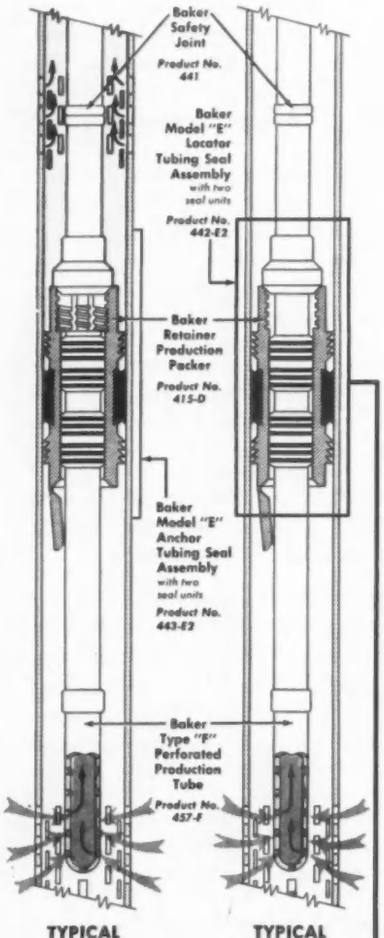
One 500-employe plant placed the elephant on the director's desk the second year after the plan was started. However, he didn't stay there. During the first year of his stay on the director's desk the plant had a disabling injury. So, "Whitie" went back to the plant.

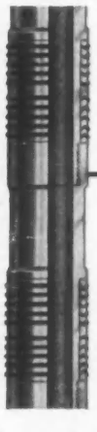
If no disabling injuries had occurred for two years in succession, the elephant would have been retired and kept out permanently.

SINGLE ZONE

DUAL ZONE
PRODUCTION

WITH **BAKER**


Baker Safety Joint
Product No. 441
Baker Model "E" Locator Tubing Seal Assembly with two seal units
Product No. 442-E2
Baker Retainer Production Packer
Product No. 415-D
Baker Model "E" Anchor Tubing Seal Assembly with two seal units
Product No. 443-E2
Baker Type "F" Perforated Production Tube
Product No. 457-F
TYPICAL DUAL ZONE HOOKUP
TYPICAL SINGLE ZONE HOOKUP



Right: Picture shows actual detail of seal units

RETAINER PRODUCTION PACKER

Do you know that with only ONE Baker Retainer Production Packer you can equip your well for *either* SINGLE ZONE or DUAL ZONE production? And that you can accomplish *any* type of completion for *any* method of production to meet *fixed* or *changing* well conditions?

A single Baker Retainer Production Packer will also outperform many specialized tools when used as a TESTING PACKER • SQUEEZE PACKER • GAS LIFT PACKER • PERMANENT COMPLETION PACKER • WATER FLOOD PACKER • GAS INJECTION PACKER • CORROSION CONTROL PACKER • TUBING ANCHOR • ONE-WAY BRIDGE PLUG • PERMANENT BRIDGE PLUG.

Every production man should be familiar with the many operating advantages of this "Universal Type" Packer, which include . . .

WIRE LINE SETTING • SETTING UNDER HIGH PRESSURE • NO EXCESSIVE "SET-DOWN" WEIGHT OR TENSION • HOLDS PRESSURE FROM ABOVE OR BELOW • PACKS-OFF AND HOLDS UNDER HIGH BHT • RESISTS CORROSION • EASILY DRILLABLE.

Ask any Baker representative or office for complete details. There is no charge and no obligation for specific recommendations and completion planning advice available from Baker Technical Advisers. Why not be prepared for your next completion?

BAKER OIL TOOLS, INC.
HOUSTON • LOS ANGELES • NEW YORK

BAKER
RETAINER PRODUCTION PACKER

If your well is worth completing . . . it's worth completing well

Lagging Demand Requires Strict Control of Supply

By L. J. Logan
WORLD OIL Staff

IN 1958 the oil industry will continue to have the serious problem of holding down supplies of crude and refined oils. Imports of oils, crude production, and refinery runs will have to be kept within the limits imposed by lagging demand for oils. This balancing of supply with demand must be achieved if industry operations are to be satisfactorily profitable.

Petroleum demand normally increases around 4 to 6 percent annually. But in 1957 it was disappointing. In 1958 it will again be subnormal. Exports will be off sharply from the unusually high levels of early 1957. Domestic consumption may be only a little if any above 1957.

Demand Below Year Ago. Total domestic and export demand for petroleum in the three months, September-October-November, 1957, was down 232,000 barrels daily—or 2.5 percent from the year-ago level, the Independent Petroleum Association of America reported. Exports were off 31.5 percent from late 1956, when the Suez crisis caused abnormally high shipments to Europe.

Domestic petroleum consumption in the September-November period of 1957 averaged only 8,590,000 barrels a day, or 1 percent less than in the same months a year ago and only 2 percent above the like period in 1955, IPAA stated.

First Quarter Demand. If continued, said IPAA, the disappointing fourth quarter demand trend would require lowering of its forecast of 9,935,000 barrels daily of domestic demand in the first quarter of 1958. The association said, however, that weather is a key factor and possibly could cause fulfillment of the forecast.

In the first quarter of 1958, export demand is expected by IPAA to average 315,000 barrels a day, a drop of 625,000 barrels from the peak of 940,000 barrels reached during the first quarter of 1957 because of Suez.

Total domestic and export demand in the first quarter of 1958 therefore is expected by IPAA to average 10,250,000 barrels daily. That would be a decline of 368,000 barrels or 3.5 percent from the first quarter of 1957.

Prospective Supply. Crude oil imports east of the Rocky Mountains in the first three months of 1958 will be 810,000 barrels a day, according to schedules filed by importing companies with the administrator of the government oil import program. West Coast crude imports, unrestricted, have been averaging about 275,000 barrels daily and threaten to rise to 350,000 in 1958, but could drop to 100,000 if the government heeds independent operators and imposes quotas there.

Domestic crude oil production in December was averaging about 6,850,000 barrels daily. IPAA continued its forecast that crude production could rise to 7,150,000 barrels daily in the first three months of 1958, assuming demand and inventories as forecast and import levels as filed with the government.

Caution Needed. In a year-end statement, P. C. Spencer, president, Sinclair Oil Corporation, warned that the oil industry, currently struggling with excessive inventories of crude oil and finished products, must exercise a high degree of restraint over the next four months, or face another year of unprofitable imbalance between supply and demand.

"Adverse developments beginning with the end of the Suez crisis last spring have completely demoralized product prices, softened the price of crude, and are squeezing profits to a minimum," he said.

Supply Required. "The industry must face the grim fact that demand for its products during the period, December 1957 to April 1, 1958, probably will be 350,000 barrels daily below the similar 1956-1957 period," Spencer stated. "That being so, refinery crude runs should be held to an average of 7,850,000 barrels daily, or 3.5 percent below last year's level, and yields of burning oil should be maximized if proper balance between supply and demand is to be accomplished."

With processing thus reduced, Spencer continued, "it would likewise be necessary to hold the new supply of raw material resulting from domestic production and imports of crude oil to an average of 7,850,000 barrels daily."

Under this projection, given a normal heating and driving season to April 1, 1958, total products would be reduced at the rate of 1 million barrels daily and crude inventories would be drawn upon at the rate of 83,300 barrels daily.

Inventories. With raw material supply and refinery runs at the levels indicated and with demand as expected, Spencer suggested that the industry "would begin the spring season, starting April 1, with crude and product inventories which would result in a healthy and wholesome state of balance in the industry, judging by past experience."

Crude oil inventory would be at 270 million barrels, down 10 million from the current (mid-December) level; kerosine and distillate would aggregate 84 million, against present stocks of 194 million barrels; residual fuel oil would measure 45 million barrels, against 59 million at present; and gasoline would be increased seasonally to 196 million barrels, compared with current stocks of 188 million.

"To achieve the inventories which will assure health in 1958," Spencer pointed out, "the industry need only maintain the present (mid-December) level of raw material supply and continue the present reduced level of refinery processing." —**The End**

Warren L. Baker, Editorial Director

January a Month of Opportunity

Continued low producing and importing levels promise that higher demand will alleviate excess inventories if refining is held to reasonable volumes.

A wonderful opportunity to substantially improve its economic position rests with the U. S. oil industry during January. Demand will be the highest since last March. A really cold month would boost demand sharply.

Despite the uncertainty of weather, demand will be sufficiently large to provide an opportunity to achieve much progress in correcting excessive inventories. To take full advantage of this opportunity, the industry must continue to exercise a high degree of restraint on production, imports and refining output.

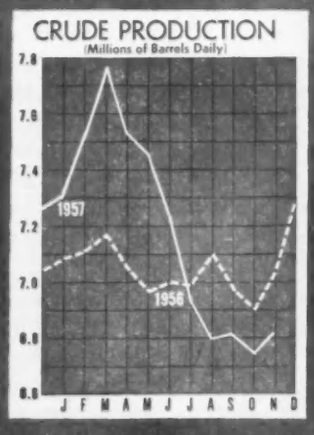
It is already assured that January crude oil production will be held near to reduced levels of recent months. There is every reason to believe crude oil imports will continue to be held to reasonable limits under the government's voluntary curtailment program. Therefore, refining activity is one uncertain factor. If refiners continue to hold refining volumes below year ago levels, January should see much improvement in the industry's economic position.

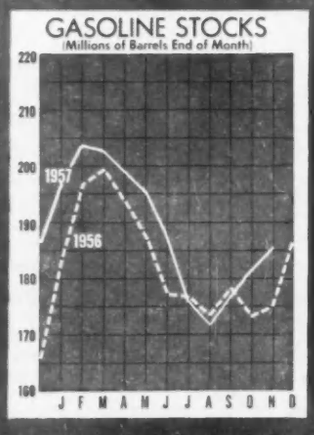
Encouraging signs of a better balance between demand and supplies brighten the outlook. Crude oil stocks have dropped sharply in recent weeks. The voluntary import curtailment program has succeeded in reducing crude oil imports. Cold weather has brought sharp reductions in distillate stocks, and fuel prices have shown improvement. Pipe line production proration is being relaxed. An import curtailment program for the West Coast appears likely.

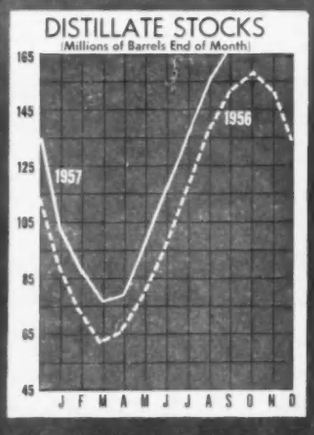
On the other hand a number of discouraging factors exist. Distillate stocks are still too high despite recent reductions. Gasoline stocks also are too large, and climbing at too fast a pace. Except for the firming of distillate fuel prices, other refined product prices show no promise of gaining strength in the immediate future. Hence, refined product prices are still exerting a downward pressure on crude prices.

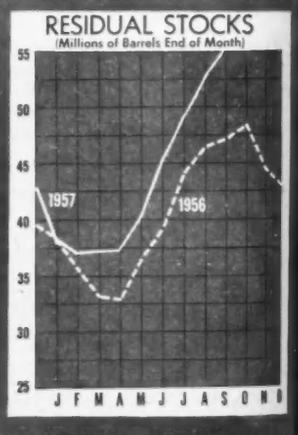
Early December saw crude oil prices in the Illinois-Indiana area trimmed by 15 cents per barrel. There also was a 25 cent-per-barrel cut by one com-

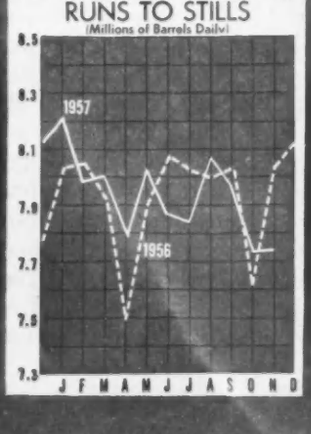
Petroleum Trends . . .

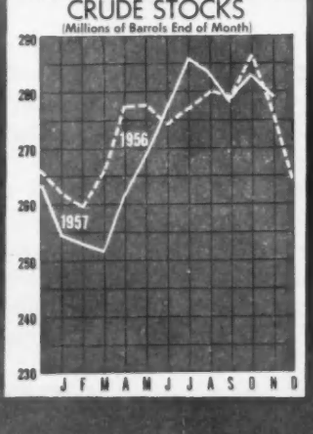


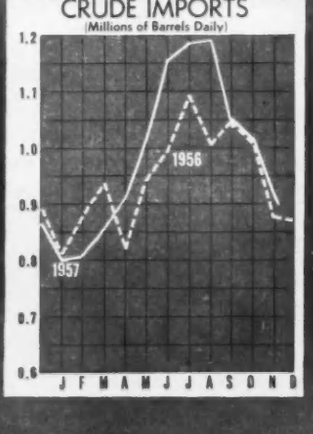


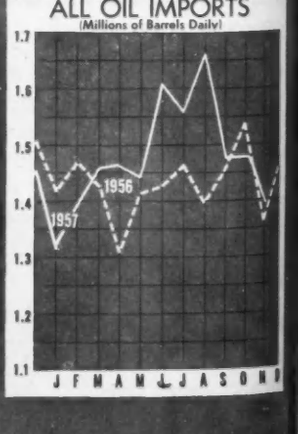












pany in South Texas, which appears to be a matter of adjustment to local competitive conditions.

Crude oil stocks improved considerably in recent weeks. On December 7 they totaled 279¾ million barrels, down 4½ million barrels from four weeks earlier. They were still 6 million barrels higher than a year ago, but there are offsetting factors. Some of the increase can be credited to heavy drafts on crude stocks in November and December, 1956, because of emergency shipments to Europe. At current levels crude stocks are the same as they were before heavy emergency shipments began to Europe in late 1956.

Furthermore, much of the 6 million barrel increase in crude oil stocks during the past year has occurred in California. Stocks of California crude are over 5 million barrels higher than a year ago. The 4½ million barrel decline in total U. S. crude stocks in the past four weeks took place despite a 1½ million barrels increase in California inventories.

Stocks of Texas crude dropped 2⅓ million barrels during the past four weeks, and now are only 1 million barrels above a year ago. Rocky Mountain crude stocks fell more than 1¾ million barrels the past four weeks, and now are 3⅔ million barrels below a year ago. Most of the other regions show relatively little change from a year ago.

Distillate fuel stocks fell sharply in the last four weeks, dropping 12¼ million barrels to 159¼ million barrels on December 13. However, they are still 19⅔ million barrels above a year ago, although they had been only 11 million barrels above last year in mid-November. Sixteen million barrels of the increase during the past year are outside of California.

Gasoline stocks rose 6⅔ million barrels during the past four weeks, in contrast with an increase of only 4¼ million barrels during the corresponding period of 1956. At present levels gasoline stocks are 11¾ million barrels larger than they were a year ago. However, 5¼ million barrels of the gain have been in the West Coast and only 6½ million barrels outside of the West Coast.

The level of distillate and gasoline stocks reflect the necessity that refining output be held to reasonable volumes in coming months.

U. S. Crude Production by States (Thousands of Barrels)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION Nov. 1957	Oct. 1957	Nov. 1956	% Diff. 1957-1956	TOTAL PRODUCTION First Eleven Months 1957	1956	% Diff. 1957-1956
Alabama	17.1	16.8	11.4	+ 50.0	4,982	2,676	+ 86.2
Arkansas	81.5	80.9	83.6	— 2.5	27,895	26,592	+ 4.9
California	926.6	933.9	950.9	— 2.6	311,035	322,178	— 3.5
Colorado	143.8	145.1	155.6	— 7.6	50,513	53,605	— 5.8
Florida	1.3	1.2	1.3	....	420	440	— 4.6
Illinois	230.3	231.1	223.8	+ 2.9	70,690	75,239	— 6.1
Indiana	32.8	36.0	35.0	— 6.3	11,775	10,333	+ 14.0
Kansas	334.4	334.3	332.9	+ 0.5	110,701	113,493	— 2.5
Kentucky	44.0	44.5	49.7	— 11.5	15,382	16,080	— 4.4
Louisiana	817.2	803.6	836.9	— 2.4	298,049	268,623	— 9.1
North Louisiana	113.1	116.0	127.9	— 11.6	42,491	42,413	+ 0.2
South Louisiana	704.1	687 6	709.0	— 0.7	255,558	226,210	+ 13.0
Michigan	26.7	27.3	28.6	— 6.7	9,354	9,986	— 6.3
Mississippi	98.5	104.8	111.3	— 11.5	35,711	37,055	— 3.6
Missouri	0.1	0.1	0.1	....	51	54	— 5.6
Montana	74.9	76.7	64.9	+ 15.4	24,796	19,510	+ 27.1
Nebraska	55.4	55.4	44.4	+ 24.8	17,573	14,601	+ 20.3
Nevada	0.1	0.2	0.1	....	27	59	— 54.2
New Mexico	253.8	251.7	243.4	+ 4.3	86,002	80,151	+ 7.3
Southeast New Mexico	249.8	248.0	239.2	+ 4.4	84,078	78,877	+ 6.6
Northwest New Mexico	4.0	3.7	4.2	— 4.8	1,924	1,274	+ 51.0
New York	7.3	7.5	7.4	— 1.4	2,478	2,517	— 1.6
North Dakota	33.1	25.9	41.4	— 20.1	12,271	12,203	+ 0.6
Ohio	16.3	16.5	13.5	+ 20.7	4,584	4,396	+ 4.3
Oklahoma	566.9	558.6	572.2	— 0.9	196,531	196,120	+ 0.2
Pennsylvania	21.3	22.3	22.4	— 4.9	7,574	7,547	+ 0.4
South Dakota	0.2	0.2	0.1	+100.0	37	33	+ 12.1
Tennessee	C.1	0.1	0.1	....	9	9	....
Texas	2,721.0	2,654.7	3,008.4	— 9.6	998,742	1,015,409	— 1.7
Dist. 1: South Central	50.1	48.6	57.5	— 12.9	17,909	18,407	— 2.7
Dist. 2 Middle Gulf	128.9	124.9	153.4	— 16.0	48,934	52,137	— 6.2
Dist. 3 Upper Gulf	407.7	401.6	444.8	— 8.4	148,136	151,225	— 2.1
Dist. 4 Lower Gulf	204.5	203.8	232.0	— 11.9	76,257	81,218	— 6.1
Dist. 5 East Central	32.2	32.4	39.4	— 18.3	12,803	14,830	— 13.7
Dist. 6 Northeast	277.7	269.9	332.6	— 16.5	108,290	114,218	— 5.2
Dist. 7-B North Central	143.1	143.5	155.2	— 7.8	52,871	52,123	+ 0.9
Dist. 7-C West Central	154.1	142.0	175.7	— 12.3	53,663	61,533	— 12.8
Dist. 8 West	1,011.4	984.6	1,100.0	— 8.1	369,165	352,048	+ 4.9
Dist. 9 North	207.4	200.7	210.5	— 1.5	69,904	70,765	— 1.2
Dist. 10 Panhandle	103.6	102.7	105.2	— 1.5	35,038	32,576	+ 7.6
Utah	12.4	12.6	7.7	+ 61.0	3,548	2,023	+ 75.4
Virginia	0.1	0.1	....	....	10	8	+ 25.0
Washington	....	....	....	....	2	....	....
West Virginia	6.3	6.4	5.9	+ 6.8	2,033	2,014	+ 0.9
Wyoming	300.7	296.8	286.1	+ 5.1	97,421	95,789	+ 1.7
Total United States	6,824.2	6,745.2	7,139.1	— 4.4	2,400,196	2,388,748	+ 0.5

Source: Bureau of Mines and API. Texas Districts from API and do not necessarily agree with State Totals.

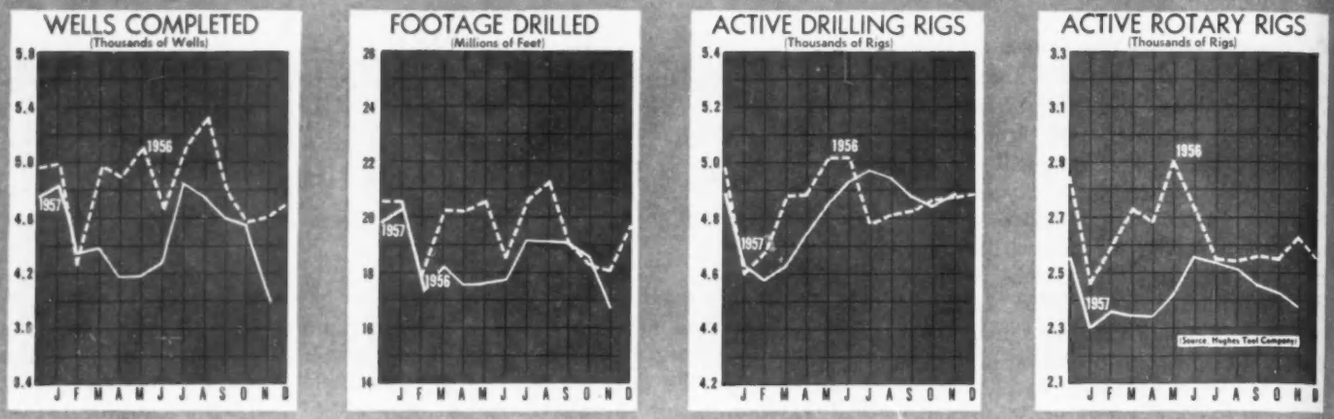
U. S. Crude Oil and Refined Product Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL Production Daily	Runs to Stills Daily	Stocks End of Month	GASOLINE Production Daily	Stocks End of Month	DISTILLATE FUEL Production Daily	Stocks End of Month	RESIDUAL FUEL Production Daily	Stocks End of Month	DAILY IMPORTS Crude Oil	Total Oils
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	1,981	133,981	1,288	44,491	873	1,471
1957:											
January	7,480	8,274	256,669	3,991	197,702	2,118	100,572	1,322	38,403	805	1,421
February	7,682	8,088	256,344	3,864	205,270	2,035	85,105	1,270	36,201	780	1,430
March	7,717	8,047	254,911	3,826	206,716	1,861	76,245	1,205	37,371	836	1,464
April	7,541	7,740	265,796	3,770	201,407	1,764	78,743	1,132	37,429	906	1,542
May	7,442	7,992	275,963	3,900	194,770	1,789	98,135	1,103	41,125	1,042	1,558
June	7,107	7,867	284,312	3,984	177,997	1,773	117,364	1,101	45,572	1,147	1,606
July	6,873	7,852	288,241	3,887	177,868	1,750	138,359	1,090	49,621	1,220	1,654
August	6,786	8,092	283,388	4,122	174,031	1,806	159,124	1,089	52,645	1,257	1,695
September	6,887	7,920	280,469	4,099	180,688	1,772	173,269	1,100	58,727	1,042	1,445
October	6,745	7,715	283,011	3,659	181,410	1,741	174,772	1,047	59,343	1,009	1,472
November	6,824	7,717	279,725	3,830	186,027	1,744	166,323	1,066	58,816	892	1,387
Week Ended:											
12-13-57	6,884	7,774	279,210	3,905	188,845	1,874	138,072	1,080	48,943	926	1,470
12-14-56	7,355	8,000	273,794	3,867	177,037	1,943	119,289	1,079	44,598	540	1,227

Source: Data for last two months from API; prior monthly data from Bureau of Mines.

Drilling Activities . . .



November's Drilling Decline Pushes Year Farther Behind

By Cecil W. Smith, WORLD OIL Staff

THE NATION'S drilling rate during November failed to hold the pace set in the previous month and dropped to the lowest point for the year. The decline widened the gap that had been separating this year's activity and last year's all-time peak operations.

A disappointing total of 3958 new wells was credited to November. That was considerably less than the 4574 completed in October, and was the lowest monthly-total in several years. Records show that 4620 new wells were completed in November of last year.

For several months, the margin of difference between this year's and last year's drilling operations had been narrowing. However, November's poor performance reversed this trend. At the end of October, the gap had amounted to 8.1 percent. A month later this margin had again risen to 8.6 percent.

At the end of eleven months, new wells completed totaled 48,829. A year ago, the total had been 53,434 for the same period. There seems little probability that the year's over-all total will go past 53,000 new wells.

While the year has been disappointing in that a new all-time high in drilling was not reached, it has produced a volume that just a few years back would have topped any previous year's performance. Any industry, especially a progressive one like the oil industry, regrets a retrogression or even a leveling off. However, if this year were the year 1954, the 53,000 new wells that will be mustered would have been heralded as the all-time peak for the industry.

November's new wells amounted to a daily average of 132, while October's had amounted to 148 per day. This was a sizable decline, but there was some justification and reason for some of the drop. The reason being the depths to which the two months' wells were drilled. In October the average depth of each well drilled was 4053 feet, while November's were taken to 4210 feet on the average. This was the highest average depth for any month this year, and probably was the record-setter for all time past. The average depth for this year's wells has been a somewhat shallower 4127 feet, which in itself is the deepest annual average ever attained.

Statistics for the year's drilling show that not only have fewer wells been drilled in comparison with 1957, but that the successful completions did not quite keep pace percentagewise. Pointing to the increasing difficulty of establishing commercial or gas production with a well are the records of the past two years. Although the difference in the two 11-months records was slight, the figures were not in favor of the current drilling campaign. So far this year, 60.1 percent of all wells drilled were completed as producers. A year ago the average had been a little better 60.5 percent. Which means that the industry will have to run a little faster just to stand still.

Summary of U S. Drilling Activity

ITEM	Nov. 1957	Oct. 1957	ELEVEN MONTHS January-November 1957	1956	Percent Diff.
New Wells Completed:					
Oil	1,908	2,299	22,260	28,179	— 10.4
Distillate	65	77	681	511	+ 33.3
Gas	295	345	3,421	3,647	— 6.3
Service	112	94	998	942	+ 5.9
Dry	1,578	1,759	18,469	20,155	— 8.4
Total Wells	3,958	4,574	48,829	53,434	— 8.6
Footage Drilled (Mln. of Feet)	16.7	18.5	201.5	215.3	— 6.4

Summary of U. S. Wildcat Drilling

ITEM	Nov. 1957	Oct. 1957	ELEVEN MONTHS January-November 1957	1956	Percent Diff.
New Field Discoveries:					
Oil	77	85	804	974	— 17.5
Distillate	5	16	113	101	+ 11.9
Gas	25	23	220	238	— 7.6
Total Discoveries	107	124	1,137	1,313	— 13.4
Dry Wildcats	794	859	9,317	10,137	— 8.1
Total Wildcats	901	983	10,454	11.450	— 8.7
Percent Productive	11.9	12.6	10.9	11.5	....
Percent Dry	89.1	87.4	89.1	88.5	....

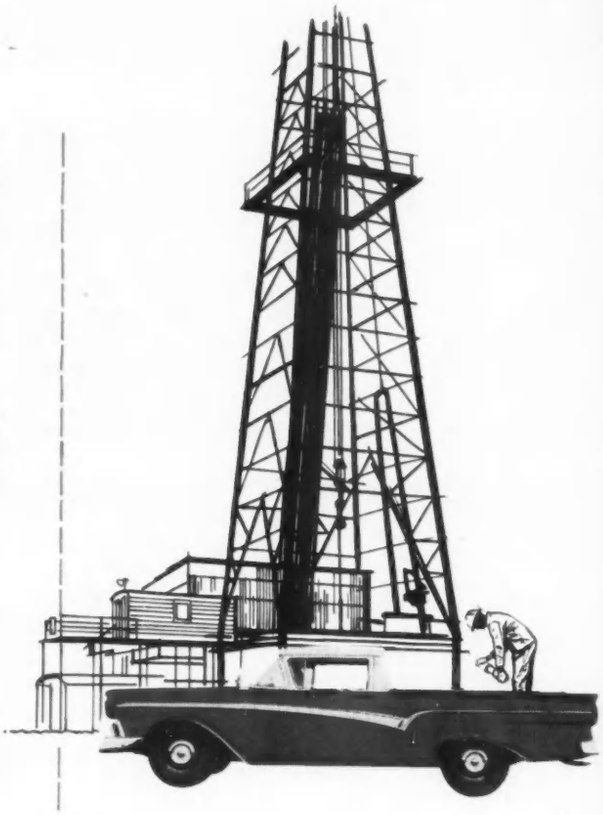
U. S. Drilling Activity in November and First Eleven Months, 1957-1956

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR NOVEMBER, 1957 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Nov. 1957	Oct. 1957	Nov. 1956	Total Footage Nov. 1957	DETAILS FOR JANUARY-NOVEMBER — NEW WELLS — 1957	1956	Percent Diff.	FOOTAGE — 1957	1956	WILDCAT DRILLING IN NOVEMBER AND FIRST ELEVEN MONTHS, 1957-1956: DETAILS FOR NOVEMBER, 1957 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-NOVEMBER — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1957	1956	DRILLING RIGS IN OPERATION — Nov. 30, 1957	Oct. 31, 1957	Nov. 30, 1956
Alabama	2	....	....	3	....	5	8	11	48,800	88	87	+ 1.1	726,958	740,062	....	....	....	3	3	....	....	1	37	38	26	12	12	16
Arizona	....	....	....	....	....	....	....	....	.....	2	7	— 71.4	4,505	22,048	....	....	....	....	....	....	....	....	2	2	7	4	4	1
Arkansas	50	....	2	28	....	80	105	103	250,098	1,018	918	+ 10.9	3,087,648	2,745,692	1	....	....	15	16	10	....	....	151	161	135	62	64	77
California	142	....	5	52	....	199	203	201	857,931	2,048	1,994	+ 2.7	8,804,961	9,200,769	1	....	....	27	28	8	....	4	325	337	264	174	166	190
Colorado	11	....	9	51	....	71	68	100	401,592	745	1,164	— 36.0	3,907,928	5,983,774	3	....	2	39	44	20	1	14	410	445	624	65	72	69
Florida	....	....	....	....	....	....	....	1	.....	8	13	— 38.5	57,082	82,307	....	....	....	....	....	....	....	....	8	8	13	2	1	2
Georgia	....	....	....	....	....	....	2	....	.....	5	7	— 28.6	25,712	30,149	....	....	....	....	....	....	....	....	5	5	7	....	....	1
Idaho	....	....	....	....	....	....	....	....	.....	1	1	.....	3,947	4,528	....	....	....	....	....	....	....	....	1	1	1	....	....	....
Illinois	108	....	6	149	....	263	246	257	600,873	2,466	3,415	— 27.8	5,675,391	7,868,285	3	....	....	76	79	14	....	1	690	705	897	260	255	266
Indiana	22	....	1	40	....	63	84	84	108,095	640	649	— 1.4	1,077,598	1,127,783	....	....	....	12	12	1	....	....	151	152	167	115	114	109
Kansas	145	....	23	147	11	326	365	402	1,141,839	3,813	4,288	— 11.1	13,500,038	15,170,722	8	....	1	73	82	108	....	24	779	911	1,134	575	603	548
Kentucky	55	....	10	93	4	162	188	137	223,284	1,643	1,717	— 4.3	2,379,304	2,552,649	....	....	....	7	7	17	....	....	95	112	134	116	135	120
Louisiana	119	22	18	131	....	290	377	309	2,306,686	3,481	3,410	+ 2.1	27,446,236	24,862,014	5	2	....	52	59	37	34	14	499	584	607	399	405	421
North Louisiana	57	1	6	46	....	110	157	154	377,766	1,320	1,507	— 12.4	4,764,631	5,434,933	4	....	....	19	23	14	2	3	158	177	216	81	83	72
South Louisiana	62	21	12	85	....	180	220	155	1,928,920	2,161	1,903	+ 13.6	22,681,605	19,427,081	1	2	....	33	36	23	32	11	341	407	391	318	322	349
* Gulf of Mexico	23	7	2	17	....	49	60	32	505,837	603	394	+ 53.0	5,748,320	3,751,653	....	....	....	4	4	7	5	3	51	66	63	74	69	74
Maryland	....	....	....	....	....	....	....	....	.....	.....	4	.....	.....	30,716	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Michigan	13	....	....	17	....	30	37	31	97,483	367	398	— 7.8	1,071,129	1,137,021	....	....	....	10	10	10	....	1	119	130	141	69	71	73
Mississippi	7	2	....	30	....	39	30	33	332,630	360	395	— 8.9	2,659,337	2,850,466	....	....	....	19	19	10	1	....	167	178	183	47	50	41
Missouri	....	....	....	1	....	1	....	....	1,537	10	25	— 60.0	7,647	27,153	....	....	....	1	1	....	....	....	10	10	16	....	....	1
Montana	13	....	....	35	....	48	45	49	223,959	392	463	— 15.3	1,912,920	2,292,846	1	....	....	26	27	4	....	4	144	152	187	49	53	59
Nebraska	24	....	1	40	....	65	71	50	374,245	818	841	— 2.7	4,844,165	4,868,657	5	....	1	27	33	35	....	2	381	418	407	31	17	28
Nevada	....	....	....	....	....	....	1	1	.....	5	6	— 16.7	11,260	36,613	....	....	....	....	....	....	....	....	5	5	4	1	1	4
New Mexico	101	2	34	30	....	167	207	171	823,691	2,047	1,817	+ 12.7	9,642,948	8,086,308	6	....	....	13	19	45	2	9	219	275	259	174	181	162
New York	21	....	1	2	24	48	48	76	69,930	471	472	— 0.2	743,600	684,200	....	....	....	....	....	....	....	....	....	....	....	68	61	78
North Dakota	13	....	....	13	....	26	40	16	165,818	263	256	+ 2.7	1,793,059	1,898,293	2	....	....	9	11	18	....	....	102	120	78	48	43	31
Ohio	57	....	16	28	....	101	74	79	241,669	938	940	— 0.2	2,252,226	2,264,082	....	....	....	1	1	1	....	....	8	9	3	222	196	228
Oklahoma	106	3	19	119	....	247	373	555	1,004,725	4,864	7,139	— 31.9	17,685,589	25,405,337	5	....	5	42	52	66	8	25	522	621	753	622	613	572
Oregon	....	....	....	....	....	....	1	....	.....	3	1	+200.0	19,396	12,880	....	....	....	....	....	....	....	....	3	3	1	1	1	....
Pennsylvania	31	....	25	6	33	95	90	112	252,601	913	863	+ 5.8	2,353,737	2,302,750	....	....	....	2	2	....	....	26	13	39	8	187	185	198
South Dakota	....	....	....	2	....	22	5	3	5,956	41	20	+105.0	140,675	67,714	....	....	....	2	2	....	....	....	39	39	19	2	1	7
Texas	822	36	75	498	40	1,471	1,710	1,705	6,426,371	19,780	20,522	— 3.6	83,303,649	86,969,732	31	3	12	297	343	371	66	72	4,103	4,612	5,027	1,250	1,188	1,261
Dist. 1 South Central	32	2	3	37	....	74	89	142	211,603	1,171	1,863	— 37.2	3,033,635	4,783,577	2	....	1	20	23	19	2	3	314	338	514	47	54	34
Dist. 2 Middle Gulf	16	5	11	23	....	55	64	54	319,674	708	750	— 5.6	4,293,547	4,603,125	....	....	1	18	19	5	16	11	214	246	249	39	30	40
Dist. 3 Upper Gulf	62	13	2	45	....	122	113	163	758,862	1,527	1,671	— 8.6	10,040,439	11,408,688	....	2	....	26	28	25	13	3	362	403	445	106	107	156
* Gulf of Mexico	....	....	....	1	....	1	2	3	8,674	10	16	— 37.5	76,651	162,082	....	....	....	1	1	1	....	....	4	5	12	1	1	4
Dist. 4 Lower Gulf-S.W.	20	12	13	46	....	91	109	122	461,892	1,303	1,333	— 2.3	6,855,462	6,954,493	1	....	1	31	33	19	8	4	381	412	461	60	72	83
* Gulf of Mexico	....	....	....	1	....	1	....	1	12,677	20	11	+ 81.8	193,945	97,098	....	....	....	1	1	....	....	....	3	3	1	2	3	2
Dist. 5 East Central	....	....	....	10	....	10	14	20	45,846	153	225	— 32.0	689,170	794,765	1	....	....	9	10	3	1	1	105	110	131	10	11	11
Dist. 6 Northeast	35	1	3	33	....	72	82	74	414,760	983	854	+ 15.1	5,327,608	4,581,758	1	....	....	19	20	8	2	4	217	231	221	59	61	77
Dist. 7-B North Central	86	....	2	104	1	193	244	205	613,727	2,491	2,763	— 9.9	8,289,396	9,856,328	9	....	....	69	78	94	....	8	833	635	1,045	211	110	104
Dist. 7-C West Central	60	1	2	26	....	89	95	67	490,309	1,087	1,144	— 5.0	5,047,320	5,228,504	3	1	1	18	23	37	2	7	264	310	304	82	77	94
Dist. 8 West	313	....	5	47	31	396	419	365	1,893,863	4,609	3,934	+ 17.2	22,521,696	20,195,740	6	....	....	28	34	83	2	5	396	486	482	372	354	343
Dis . 9 North	147	1	4	106	8	266	354	391	746,468	4,407	4,692	— 6.1	11,760,499	13,448,616	8	....	2	47	57	67	3	8	919	997	1,044	233	193	212
Dist. 10 Panhandle	51	1	30	21	....	103	127	102	469,907	1,241	1,293	+ 3.7	5,447,788	5,114,138	....	....	6	12	18	11	17	18	98	144	131	121	119	107
Utah	18	....	2	16	....	36	35	19	198,262	249	134	+ 85.8	1,366,083	627,333	3	....	....	13	16	12	....	3	93	108	85	62	69	31
Washington	....	....	....	....	....	....	....	....	.....	4	1	+300.0	20,459	7,493	....	....	....	....	....	....	....	....	3	3	1	1	1	....
West Virginia	2	....	41	12	....	55	68	48	148,852	606	635	— 4.6	1,661,307	1,720,910	....	....	1	1	2	....	....	12	12	24	26	175	177	195
Wyoming	26	....	7	35	....	68	93	67	357,293	740	832	— 11.1	3,311,309	3,647,677	3	....	3	27	33	17	1	8	221	247	236	96	105	92
Total United States	1,908	65	295	1,578	112	3,958	4,574	4,620	16,664,190	48,829	53,434	— 8.6	201,494,803	215,328,963	77	5	25	794	901	804	113	220	9,317	10,454	11,450	4,889	4,844	4,882
Total Western Canada	181	....	25	77	6	289	218	480	1,348,304	2,814	2,813	+ 0.1	13,119,524	13,116,683	....	....	....	....	....	....	....	....	....	.....	.....	162	168	222

* Gulf of Mexico wells are included in their respective District totals.

another DST improvement

HALLIBURTON'S NEW ACID FORMATION CLEANER



30 SECOND TECHNICAL DESCRIPTION

Heart of the Cleaner is the acid pump, operated by application of drill pipe weight, and run directly above the testing tool. The proper mixture of acid (as determined by well conditions) is retained in the pump between the closed tester valve at the bottom and a disc type valve at the top.

When the tools reach bottom and the tester valve opens, the acid flows through fluid passages and is placed adjacent to the formation. The mud below the packer is displaced through a by-pass to the annulus above the packer. Chemical action between the acid, mud and formation tends to eliminate or reduce hole damage.

At the conclusion of the chemical reaction, the disc type valve above the pump is opened by a built-in spear which allows the formation fluid and the spent acid to enter the drill pipe. All subsequent operations are the same as for a conventional drill stem test.

Here's why:

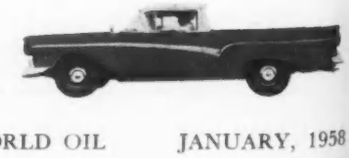
Potentially productive formations can now be washed with fast-acting acid before testing... removing or minimizing hole damage caused during the drilling process. The new Halliburton Acid Formation Cleaner is especially valuable in areas where zones of very low formation pressure can be blocked by mud filter cake alone.

The new Halliburton Acid Formation Cleaner is just one more reason why it pays to specify Halliburton Testing Services for your well. For the best in testing, call Halliburton!

HALLIBURTON TESTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY, DUNCAN, OKLAHOMA

FOR TESTING RESULTS YOU CAN TRUST



Discovery Challenge of the Rockies

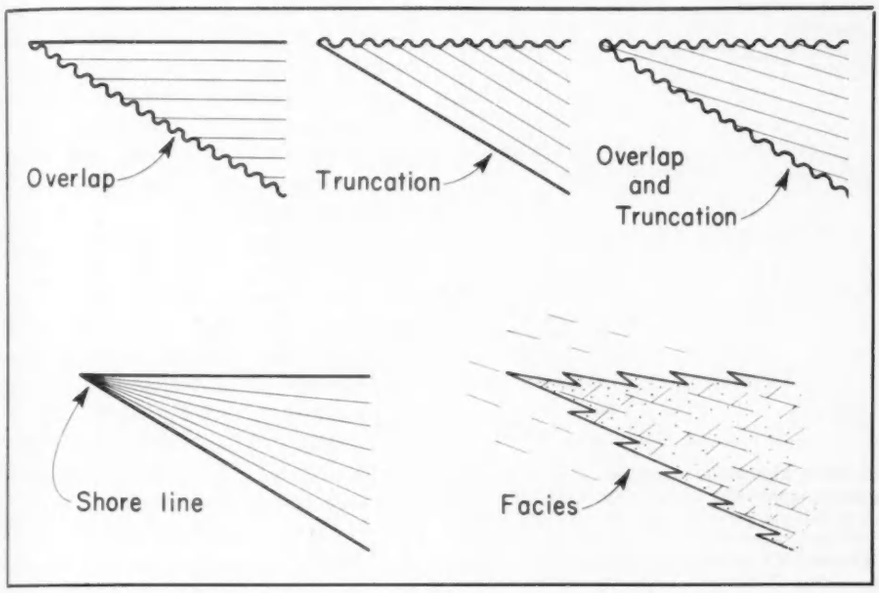


FIGURE 1—Common ways in which formations wedge-out. Note that in each sketch the cross section has the same wedge shape, but that each was formed in a different manner.

While the Rockies once had an abundance of closed structures, there now appears to be an abundance of wedge-outs of local, regional and continental extent.

By A. I. Levorsen
Tulsa

TEN YEARS AGO the petroliferous possibilities in the Rocky Mountain region were tremendous. Today, despite the many new discoveries, it is safe to say that the possibilities are even greater than ever.

A lot of wells have been drilled and many pools discovered. Some observers might believe that, because of these discoveries, there should be less oil in sight now, instead of more.

That would be correct if anyone had any idea of the ultimate amount of oil there is present within the Rocky Mountain region. But no one knows or can even come close to knowing. The ultimate amount will be unfolded slowly and only after the geology has been revealed and countless more discoveries made. As we explore, we learn more of the geology, the geologic history, and the kinds of traps that occur and produce oil and gas. It is this knowledge that gradually translates into a firmer idea of the ultimate reserves, but even an approximate amount will never be known short of drilling many thousand more wells to the basement.

There are two thoughts that should be kept in mind. The first is that running out of closed anticlines to drill does not mean running out of oil. The second is that we are moving into an era where finding traps requires much more geologic data and much more geological analysis than heretofore.

Two fundamental problems are basic to an analysis of the future discoveries of petroleum for any region, including the Rockies. They are:

- Are there substantial quantities of oil remaining to be discovered?
- Can they be discovered?

Let us dispose of the first problem quickly. The Rocky Mountain region is blessed with one of the most complete and well developed geologic sections in the whole of North America. We see, for example, the Tertiary system well developed in the California and the Gulf Coast provinces where it contains most of the petroleum; the Mesozoic likewise in East Texas and Northern Louisiana; and the Paleozoic in the West Texas, Mid-Continent and eastern states provinces. But the Rockies have every system in abundance, and each at some place or other has been found to be productive—even including the continental Tertiary.

In spite of the abundance of sedimentary rock to drill, however, the drilling density is very low; it is but a small percentage of any of the other great provinces of the U. S. Consequently, what we know of the geology of the Rocky Mountain region now, at best, is but a tiny fraction of what there is to know. Every formation of every age in every state contains unknown stratigraphic phenomena such as facies changes, lenses, permeability changes, truncations and overlaps. It is these that form traps, either with or without local structures. The tiny fraction of geology we know is responsible for the oil of the past. How much greater then, must the petroleum of the future be as the vast unknown geology is gradually revealed by the drill?

Until the drilling density is many times greater than it is now, no one can say what the undiscovered reserve may be. Based on a knowledge of how little we know of the geology, on the large volume of untested marine sedimentary rocks, and on past experience in the Rocky Mountain region, we can say, however, and with much assurance, that there are great quantities of petroleum yet to be discovered. Whether these undiscoverd re-

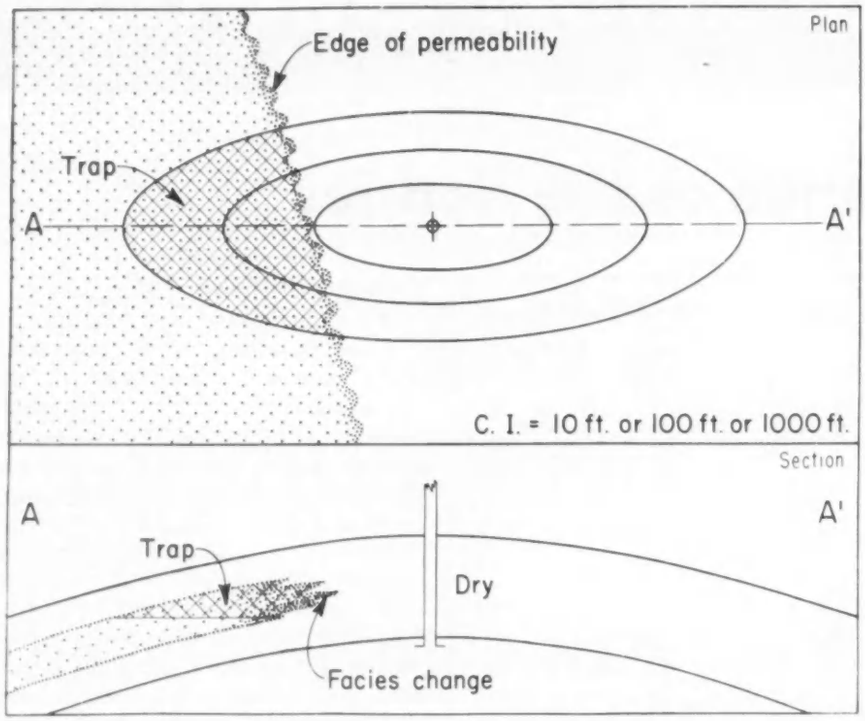


FIGURE 2—Shown here is a combination trap formed by the facies pinch-out of a permeable formation across the peri-anticline of a dome. The stratigraphic part of the trap could be on any side of the fold and could intersect the structural part at any point between the top of the fold and where it merges with the regional dip. And, since folding is involved, there could be a succession of traps of this kind in any of the potential reservoir rocks between the surface and the basement.

serves are equal to past discoveries, five times as much or ten times as much is anyone's guess, but that they are large is certain.

The second problem—Can they be discovered?—is more difficult to assess and it is the real challenge of the Rockies. It is as if they were saying, "Yes, it is here, but try to find it!"

If we look at exploration in perspective, we see that almost everywhere it tends to follow a pattern. The first rule, as every person in the oil business knows, is to drill on the top of closed anticlines, and we may call this Phase I of the pattern. It requires little imagination but frequently much ingenuity in one's ability to map structure correctly.

Where a closed anticlinal trap is present, it has two important advantages over other kinds of traps, advantages that have accounted in large part for the high regard it has among wildcatters. First, it can be localized areally from the surface, either by surface mapping, core-drilling, seismic surveying, subsurface methods or by combinations of these. Knowing the location of the top of the fold provides a definite reason to place the first test well at a specific point—even though no other wells have been drilled within many miles of the location. Secondly, once a closed structure has been located, it means there will be a succession of traps in every potential reservoir rock encountered from the surface to the basement. One test well, therefore, tests several or many traps. These inherent advantages will make structural traps Grade A prospects as long as untested structures can be found.

The second or Phase II of the exploration pattern involves more stratigraphic data and can only come when stratigraphic details become available. Even if a test well on the top of a structure is dry, it furnishes useful data on reservoir rocks, fluids, facies, correlations, and many other previously unknown variables. These stratigraphic data, combined with the structural data, enable one to locate additional traps.

Finally, after Phases I and II, the last, or Phase III can be seen. It is concerned with the search for oil and gas in non-structural traps such as reefs or lenses and patches of permeable rock, along irregular up-dip edges of permeable facies, drilling near oil and gas showings, or drilling at random. The clues to favorable trap conditions in Phase III are generally obscure and the lack of good data must be balanced by an increase in the courage needed to drill. We have only to look at the San Juan fields in New Mexico and then 1200 miles to the north a look at the Pembina field in Alberta, to realize the possibilities of non-structural Creta-

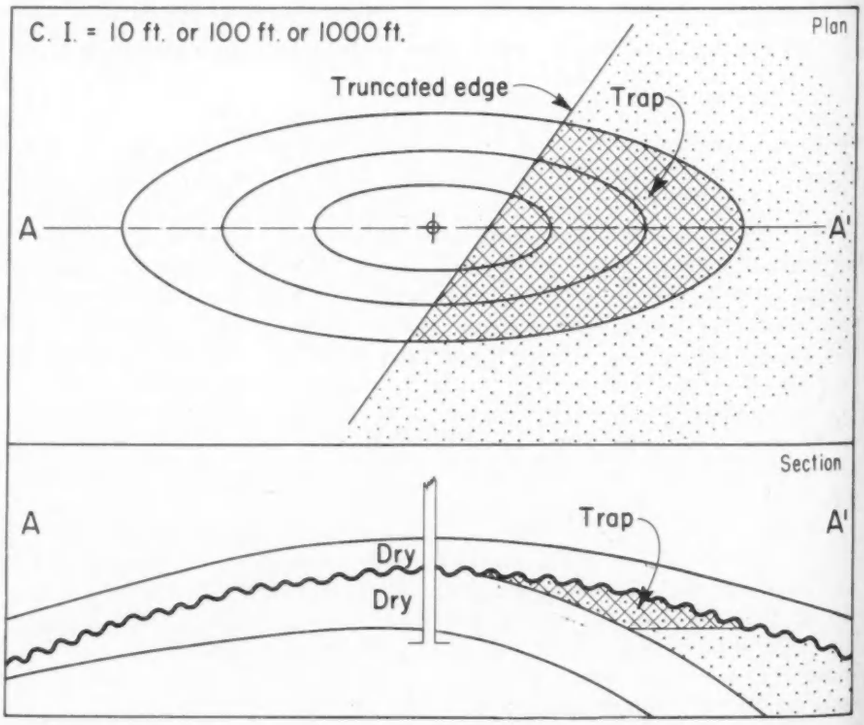


FIGURE 3—A combination trap, the stratigraphic half formed by a regional uplift, truncation and overlap of a permeable formation by an impermeable rock, and the up-dip pinch-out of permeability crossed by the structural half of the arch formed by the plunge or pericline of the dome. The stratigraphic pinch-out could be on any side of the dome and the pinch-out might cross the arch at any point down the plunge and still form a trap.

ceous oil and gas pools throughout the intervening region.

The Cretaceous occurs almost continuously in between and everywhere the stratigraphy is characterized by facies changes. But the Cretaceous is only one of the systems that is at the same time extensive and contains many wedge-outs—the same could be said of nearly every other system in the Mesozoic and Paleozoic, with some Tertiary thrown in for good measure.

These different phases overlap in some areas and in other areas one may be missing. The Rocky Mountain region has long been in Phase I, but it is gradually passing into Phases II and III, or combination trap and stratigraphic trap exploration. The geologist must rely on and have available more accurate subsurface information, logs, detailed geophysical surveys, well samples, core analyses, underground fluid data and many minor and indefinite bits of information. These are the phases that require the most precise geological data, the most imaginative prospecting, and the greatest reliance on theoretical principles of geology.

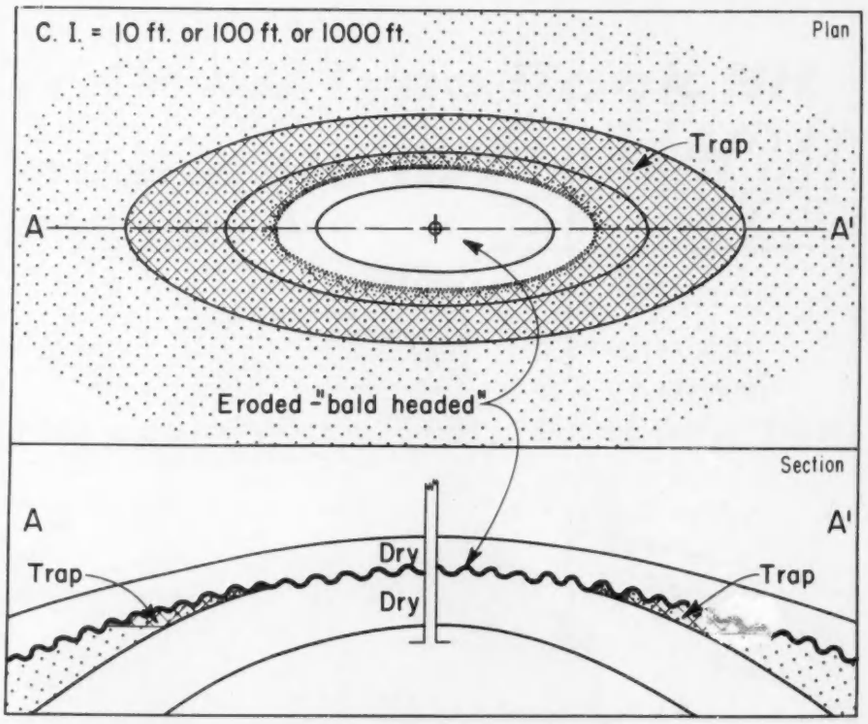


FIGURE 4—This shows a combination trap formed by early folding followed by truncation of the top leaving the crest barren of reservoir rock or "bald headed" as these are sometimes called in the Mid-Continent region. The wedge-out edge could be tilted at a different angle than the structure contours and one side be higher than the other, thereby localizing the pool on the high side instead of uniformly around the dome as shown.

A stratigraphic type trap is frequently formed where a permeable formation wedges-out up the dip and is crossed by a fold or arch or where an irregular edge of a permeable formation extends farther up a uniform dip than usual and thereby forms a trap. Wedge-outs of permeability exist in great abundance; there are probably many thousands of miles in the Rocky Mountain region. The search for stratigraphic traps consists in large part in locating these up-dip wedge-outs of permeable formations and to do this it is generally helpful to know how the wedge-out was formed. Five common ways in which wedge-outs may have been formed are shown in Figure 1, and each has been responsible for many traps in which oil and gas have accumulated.

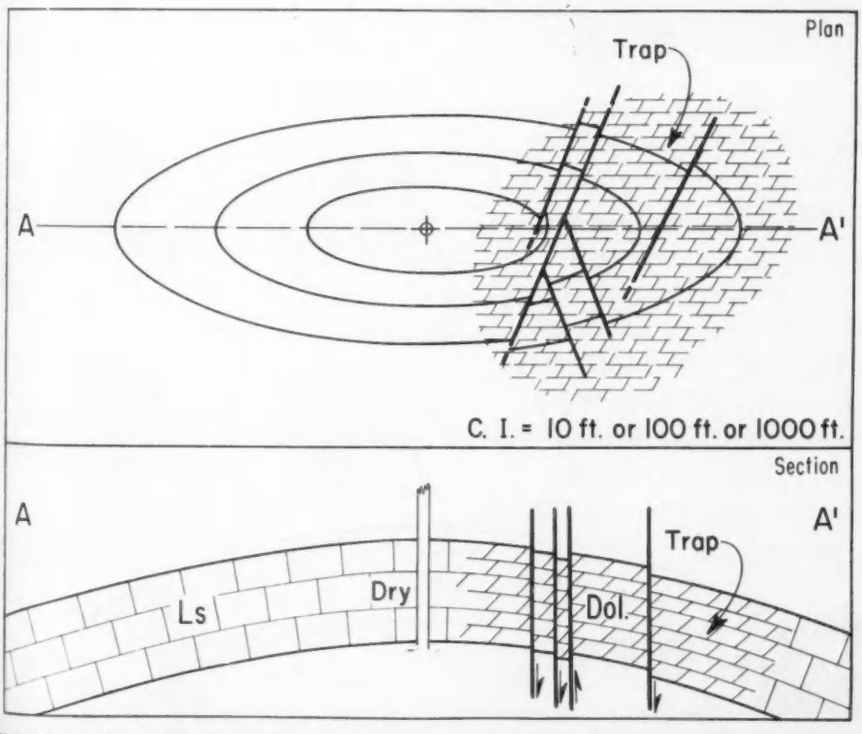


FIGURE 5—This trap is formed by a patch of secondary dolomite that presumably came up along small faults and fractures that are associated with the fold. The path for the dolomitization could also become the path for oil and gas.

Now let us look at just one type of prospect—the dome on the top of which a dry hole has been drilled to the basement. What to do next? Is that the end of that dome as a prospect? There are hundreds of such examples in the Rocky Mountain region, and there are many in other provinces, and I would like to point up some of the prospects that still remain. A dry hole on the top of a structure does not necessarily condemn the structure. It may, in fact, become the clue to where a pool is located.

Six sketches, Figures 2 through 7, show some of the kinds of traps that may still exist on any dome that has been tested dry on top. The fold is the same in each sketch and the potential reservoir is shown to have been tested dry or barren by a hole drilled at the highest point of the structure. The contour interval in

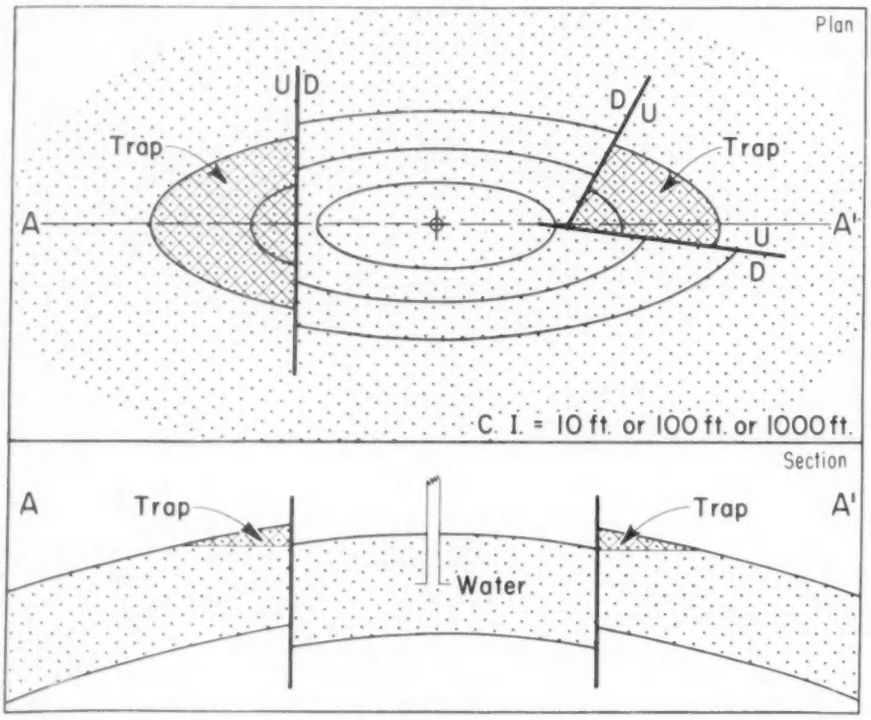


FIGURE 6—Traps formed by small faults associated with the fold. The displacement of these faults may increase or decrease with depth, depending on the geologic history of the area. They may be on any side of the fold and may occur at any point down the plunge or pericline.

each may be 10 feet, 100 feet, or 1000 feet and the corresponding area covered by the closure may be 10, 100, or 1000 square miles. You may think of the features illustrated as any one of the hundreds of small domes, or the dozens of large domes such as the Zuni, San Rafael, Black Hills uplifts that are found in each of the Rocky Mountain states. In four of the examples, folds are combined with stratigraphic phenomena, one with minor faulting, and one with hydrodynamic conditions. These sketches are of single features, and are quite simple. One or more, however, could combine to form more complex traps. The trap could occur near the top of the fold or far down the plunge or peri-anticline. In addition, any one or any combination of several could occur in any one of the folded formations between the surface and the basement.

One fact to consider when thinking about these sketches is that before the top of the dome was tested, 100 percent of the trap was in the closure. After the top of the closure was tested dry, however, there still remain many half-traps formed by the peri-anticlines around the flanks of the fold. Each arched or curved surface acts as an open anticline and can combine with some stratigraphic element, buried faulting, or hydrodynamics to form a trap. For that reason it frequently is better prospecting to stay close to dry holes on folds or along open anticlines, because there a necessary part of the trap is already assured.

When we consider all of the possibilities for combination traps associated with the flanks of domes, both small and large, by one feature or by combinations of several features, either near the top of the fold or far down the plunge, and for each of the formations that are folded, it can be seen there are still a lot of holes to be drilled before all domes can be said to have been completely tested.

While the Rockies once had an abundance of closed structures, there now appears to be an abundance of wedge-outs of local, regional and continental extent. Some are really large, as for example the 30- 40,000 feet of pre-Cretaceous sediments in Nevada and western Utah that thin out completely in northern Colorado where late Jurassic and Cretaceous rocks rest directly on the Precambrian basement. And when one thinks on a bigger scale of some of the large folded tectonic features of the Rockies, in combination with some of the wedge-outs of thick reservoir rocks, the possibilities that there may be some elephant-size pools to be discovered becomes really exciting.

—**The End**

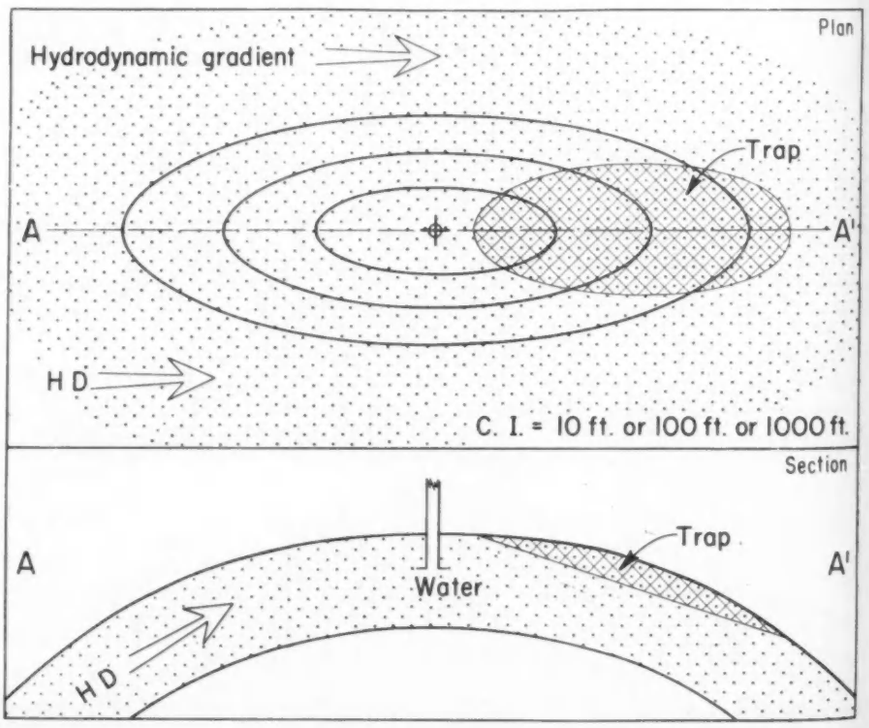


FIGURE 7—Trap formed by a combination of the fold with a hydrodynamic gradient within the reservoir rock. The gradient could come from any direction, could be used for any rate and the pool would be displaced in the direction of the gradient any distance, even until flushed out.

..a NEW Cone Type Rock Bit now available in CANADA!

for faster, more efficient drilling in harder formations

TO SPEED CANADIAN EXPLORATION

HAWTHORNE "BLUE DEMON" BITS FOR ALL-FORMATION DRILLING

PILOT BLADES
For Soft Formations

FINGER BLADES
For Medium Formations

INSERT BLADES
For Medium-Hard Formations

CONE-TYPE ROCK BITS
For Harder Formations

A Hawthorne subsidiary, a new stocking point to service authorized Canadian dealers, has been organized in Canada, with offices in Edmonton . . . to provide faster, more efficient "Blue Demon" Bit Service in all the active exploration areas of Western Canada.

Field sales representative is Carey Gunn, widely known throughout the Canadian exploration industry, and long familiar with Hawthorne's Bits, service and sales policies. Adequate stocks of the new Cone-Type Rock Bit and "Blue Demon" Replaceable Blade Bits, in the most popular exploration drilling sizes . . . as well as stocks of bit body parts . . . are now available, and will be continually maintained.

Consistently priced . . . wherever you go in Canada . . . Hawthorne "Blue Demon" Bits will be on hand for all your drilling requirements.

WRITE FOR ILLUSTRATED CATALOG

HERB J. HAWTHORNE (Canada) LTD.

6010 104th STREET • EDMONTON, ALBERTA • PHONE 39-0770

HOME OFFICE: P. O. Box 7366 • Houston 8, Texas • Cable Address: HAWBIT

East Texas Basin Offers New Type Fields

Recent discoveries have directed exploration toward three objectives:

- **Flanks of interior salt domes**
- **Deep formations of fault zones**
- **Shallow formations along south rim of basin**

By Joseph A. Kornfeld,
Consultant, Tulsa

EXPLORATION IN THE East Texas Basin has been greatly stimulated by a recent series of significant discoveries. The new fields have been found in several different types of exploration.

The significant developments have included the following:

- A Smackover limestone discovery at Powell, Navarro County.
- Stepped up development in the Smackover gas-distillate reservoir at New Hope field, Franklin County.
- Revived development of the interior salt domes, following two oil discoveries from the Woodbine sandstone at Hainesville in Wood County and Bethel in Anderson County.

The new search is being concentrated into a series of exploration objectives:

- Interior salt domes.
- Deep drilling along pronounced fault zones.
- Stratigraphic exploration on the south rim of the basin.

Rocks of Jurassic, Cretaceous, and Eocene age have yielded the production in the recent discoveries on the flanks of several interior salt domes and along fault segments of the Mexia and Talco fault systems.

For special attention and discussion here, several recent significant developments are cited, as follows:

- Jurassic gas-condensate development at Powell field, Navarro County, highlights current work in the *up-dip* Mesozoic belt.
- Jurassic gas-condensate development in the New Hope field, Franklin County, features current operations in the *down-dip* Mesozoic belt.
- Cretaceous discoveries indicate new reserves on the flanks of certain piercement-type interior salt domes in Anderson and Wood Counties.
- Eocene-Wilcox sandstone oil discovery at Boggy Creek field points to new shallow formation objective for the southern end of the East Texas Basin.

Rich Basin. The East Texas Basin is one of the richest on the North American continent. Approximately 5 billion barrels of proved, developed oil reserves will be recovered from it.

This basin occupies that portion of Texas which is bounded on the north and west by the Balcones fault system, on the east by the Sabine uplift, and on the south by the Gulf Coastal plain.

The Sabine uplift is a large domal structure which centers in Panola county, Texas, and extends eastward into northwestern Louisiana. Structural influence of this uplift in northeast Texas extends from Marion county on the north to Shelby county on the south, a distance of about 80 miles.

A local term, Tyler basin, has been applied to that portion of this region which lies immediately west of the Sabine uplift. The Tyler basin comprises a large trough in the Mesozoic and Cenozoic rocks extending for 120 miles in length and 50 miles in width.

The major axis of this trough extends from Leon county in a north-northeastward arcuate direction towards Cass County. The principal structural characteristic of the Tyler basin is the occurrence of 16 piercement-type salt domes and a smaller number of deep-seated salt domes within the heart of this basin, which centers at Mineola in southern Wood county. Local faulting is associated with most of these domes.

Two major zones of normal faulting pass near the inner margin of the Gulf Coastal plain of Texas. These form the north and west boundaries of the East Texas basin.

One of these zones, known as the Balcones fault system, lies essentially at the margin of the coastal plain, but passes from its strongest development in Comal and Hays counties in a northeastward direction to form the westward boundary of the East Texas basin. Maximum displacement at the surface is as much as 500 feet in Comal and Hays counties. The system is comprised mainly of large, discontinuous normal faults, dipping to the coast. The western limit lies in Uvalde county. The northern limit of important faulting is in central Williamson county.

A second zone of faulting lies down-dip and east of the Balcones fault zone. The downthrown side is generally to the west and to the north. This line of faulting is known as the Luling fault system. It takes its name from the Luling fault block in Caldwell county, where there are displacements of the magnitude of 500 feet or greater. The system merges at the west in Medina county with the complex development of the Balcones fault system.

The third zone of faulting extends from Mexia in a north to northeastward direction to near Greenville in Hunt county. Still a fourth zone is the Talco group of faults, which exhibit a west-east direction towards Bowie county in extreme northeast Texas. The latter three zones have been referred to regionally as the Luling-Mexia-Talco fault system.

JURASSIC EXPLORATION

Up-Dip Development. During the past 15 years, a series of oil and gas-condensate discoveries have been completed from rocks of Upper Jurassic

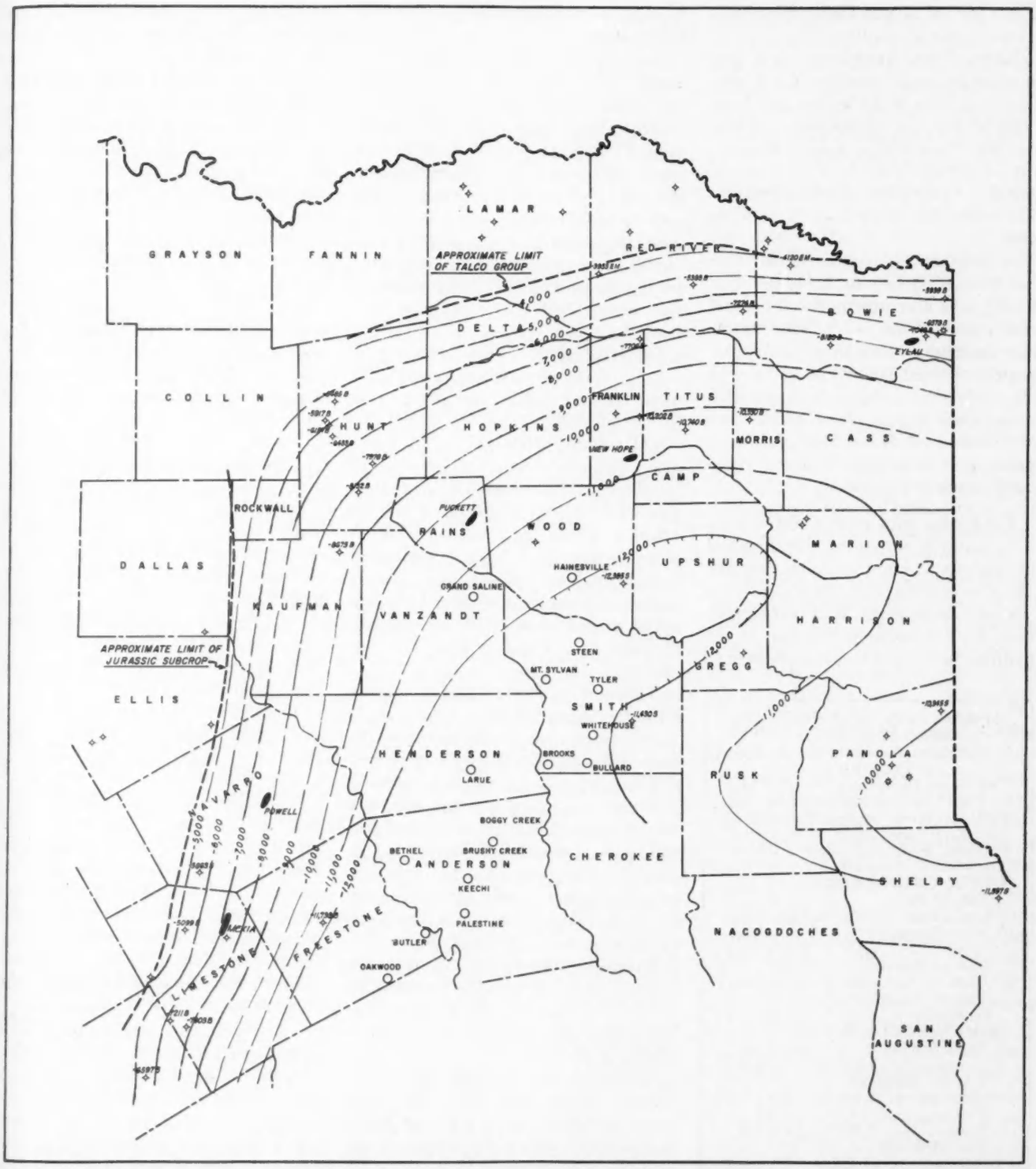


FIGURE 1—Subsurface structural contour map of the pre-Cotton Valley Jurassic in the East Texas Basin. Symbols: EM-Eagle Mills formation; S—Smackover formation and B—Buckner formation. (In part after F. M. Swain, AAPG Bulletin, Vol. 33, No. 7, July 1949).

age located on local fault structures extending along a 150-mile trend within the Mexia and Talco fault systems.

The most recent of these discoveries was completed this spring on the Powell fault in Navarro county from the Smackover formation. This find had been preceded by completion of two producers from this formation located on the Mexia fault of Limestone county.

Powell-Smackover

Structure . . . The Powell fault exhibits an average strike of N 37° E. The total displacement of the major field fault ranges from 650 feet at the level of the Austin chalk to about 2400 feet at the top of the Smackover formation.

The discovery well in the Smackover reservoir at Powell was completed on March 4, 1957, at the Texas Company's J. N. Edens 1, located on a 161-acre tract in the James Smith Survey, Abst. 276., about two miles northwest of the field proper. Company geologists had expected to observe a loss of 850 feet of section. But

2,400 feet of Lower Cretaceous rocks were cut out by faulting.

Edens 1 was completed as a gas-condensate well through casing perforations from 8730-70 feet and from 8869-90 feet. Initial open-flow potential was 18,500,000 cubic feet of gas plus 370 barrels of 61.8° condensate per day. Gas-condensate ratio was 50,725 cubic feet per barrel of condensate.

A series of 19 diamond cores were cut from 8705 feet to 9244 feet total depth, which represented 539 feet of continuous coring, all in the Smackover formation. Salinity of cores analyzed remained below the salinity of the drilling mud, (a maximum of 5000 ppm) until a penetration of 525 feet of Smackover formation had been penetrated in a basal coarse-grained conglomeratic sandstone.

Hydrocarbon phase distribution . . . From a review of the diamond cores cut throughout the upper Smackover formation and two drill-stem tests conducted in the upper portion, the following distribution of the hydrocarbon phases was established:

FORMATION SEQUENCE OF MESOZOIC ROCKS
Southern Portion of the East Texas Basin
The Texas Company's W. M. White 1, 1980 feet from the east line, and 1700 feet from the west line of William King survey, four miles west of Fairfield, Freestone County, Texas. Elevation 408 feet DF.

UPPER CRETACEOUS:		
Top of Pecan Gap chalk	2,580 ft.	(-2172 ft.)
Top of Austin chalk	3,450 ft.	(-3042 ft.)
Base of Austin chalk	3,859 ft.	(-3451 ft.)
Top of Woodbine formation	4,200 ft.	(-3792 ft.)
LOWER CRETACEOUS:		
Top of Buda limestone	4,658 ft.	(-4250 ft.)
Top of Goodland limestone	5,450 ft.	(-5042 ft.)
Top of Rodessa	7,152 ft.	(-6744 ft.)
Top of Pettit limestone	7,725 ft	(-7317 ft.)
Top of Travis Peak formation	7,905 ft.	(-7497 ft.)
UPPER JURASSIC:		
Top of Cotton Valley formation	9,860 ft.	(-9452 ft.)
Top of Buckner formation	11,946 ft.	(-11,538 ft.)
Top of Smackover formation	12,615 ft.	(-12,207 ft.)
Total Depth	14,331 ft.	(-13,923 ft.)

The lithologic character of the Smackover formation as observed from diamond cores reveals a considerable variation in both the character of the rock itself and the porosity development.

Gas cap lithology . . . Lithology ranges from dolomitic, saccharoidal limestone to fine to coarse, crystalline dolomite with veins of crystalline dolomite frequently present. Agrillaceous zones are present throughout the zone studied. Porosity development in the top of the Smackover formation comprise good inter-granular porosity with vugular types present. Fracture porosity is very prominent. Along the solution planes, carbonaceous shales have been deposited.

Occurrence of hydrocarbons is among (1) intergranular porosity, (2) along fracture planes, and (3) in veins of crystalline dolomite.

Oil column lithology . . . A gradation between dolomitic limestone to agrillaceous, limey dolomite has taken place in the upper portion of the oil column. Dense gray dolomitic limestone lentils have been intercalated with stringers of dense, black, agrillaceous dolomitic limestone. Thin layers of carbonaceous shale are present. Porosity is found along fracture planes.

There is a downward gradation from the above lithology to very agrillaceous limestone to silty to limey siltstone with laminated bedding planes.

Limey shale is found along bedding planes. Veins of calcite and dolomite are common. Thus the amount of dolomite decreases sharply downward in the oil column so that the lithology now comprises agrillaceous silty gray to black, hard, non-porous limestone containing laminations of limey carbonaceous shale partings. Porosity development has decreased considerably and the principal occurrence of hydrocarbons has taken place along bedding planes.

Cores cut in the base of the oil column range from very silty limestone to dense limey, gray, agrillaceous, siltstone with poor porosity development. This grades into an agrillaceous, anhydritic sandstone ranging in texture from very fine to coarse grained to slightly conglomeratic rock.

Water phase lithology . . . In this phase, the lithology commences with vugulated granules set in white, dense anhydrite. Oil stainings occur in these vugulated granules.

Mexia-Smackover. Jurassic production was first obtained on the Mexia fault in Limestone County on February 10, 1955. The discovery well was Humble Oil & Refining company's Joe Ross heirs 1, located 167 feet from the northeast line and 467 feet from the northwest line of a 35.15-acre tract in the Pedro Varela survey, 4.3 miles southwest of Mexia. It was completed for an initial flowing potential of 252 barrels of 63.7° gravity oil per day produced through a ¼-inch tubing choke. Initial shut-in tubing pressure was 685 psig, and shut-in casing pressure 1120 psig. Initial produced gas-oil ratio was 4860 cubic feet per barrel.

This well was drilled to a total depth of 8619 feet in Smackover formation encountered at 8560 feet. The 5-inch oil string was set and cemented five feet off bottom and perforated from 8565-76 feet.

Although oil production fell off rapidly and gas-oil ratios rose sharply during the first several months of production, this discovery was significant in that it extended the productive belt of Jurassic fields about 100 miles to the southwest of the Ginger gas-distillate field in Rains County. Prior Jurassic exploration found gas at Flower Acres and Eylau in Bowie County, New Hope in Franklin County and Puckett in Rains County.

The Mexia discovery was finally shut in as a statutory gas well after producing 13,146 barrels of condensate.

The second gas-condensate completion for the Mexia-Smackover field was Humble's Joe Ross heirs "B"-1, located 467 feet from the northeast line and 467 feet from the southeast line of a 86.42-acre tract in the Pedro Varela survey. It was completed December 16, 1955. It found the Smackover 45 feet structurally higher than the discovery well.

This well was drilled to a total depth of 8647 feet at a 116-foot penetration of the Smackover formation encountered at 8531 feet. The 5-inch production casing was set three feet off bottom and perforated for completion from 8536-8549 feet. Initial flowing potential was 7.5 million cubic feet of gas per day. Accompanying condensate production was 455 barrels of 66.0° gravity distillate per day. Initial produced gas-condensate ratio was 16,500 cubic feet per barrel.

Last year, a third deep test drilled on the Mexia structure found the Smackover formation 149 feet lower structurally than did the discovery well. It was Humble's L. W. Rogers 1 which logged the Smackover at 8756 feet and after being drilled to a total

depth of 9221 feet, was abandoned as a dry hole on October 10, 1956.

Down-Dip Development. The future exploration pattern for Smackover exploration in the East Texas basin appears to be a 150-mile long down-dip belt. This exploration strip extends from the Mexia field in Limestone County on the southwest in a northeastward direction along the Mexia-Talco fault system traversing Navarro, Freestone, Henderson, Van Zandt, Rains and Hopkins counties, where it turns in an eastward direction towards the Louisiana state border line and crosses Franklin, Titus, Morris, and Cass counties in Texas.

New Hope field . . . The most promising field discovered to date in this down-dip Jurassic belt is the New Hope field situated six and one-half miles southeast of Mount Vernon in Franklin County.

The discovery well from the Smackover formation was completed during January, 1954, by Tidewater Oil Company and Seaboard Oil Company. Their Ramey Unit 1, John Maximilian survey, was completed from open hole in Jurassic limestones from 12,096-12,331 feet, plug-back depth. Initial potential was 4.5 million cubic feet of gas and 608 barrels of 61.5° gravity condensate per day produced through an 18/64-inch choke.

Since that date, Tidewater and Seaboard have completed five additional gas-condensate producers from the Smackover formation. Gross pay sections in excess of 600 feet have been logged. Plans have been made for gas cycling and pressure maintenance operations .

Economic factors which should implement the search for deep Smackover reserves along this belt include:

1. High condensate recovery. (Condensate recovery at New Hope is about 150 barrels per million cubic feet, from flash separator.)
2. Thick gross pay sections. Approximately one-half of the 600-foot gross pay sections at New Hope is considered to be met effective saturation.
3. Additional revenue through plant extraction of high sulfur content.
4. High recovery effiiciency through pressure maintenance and cycling of retrograde gas.

Geological problems . . . Several wells in the heart of the East Texas basin have failed to encounter the Smackover formation above the Eagle Mills salt on deep-seated salt domes. A few of these examples follow:

Van Field: The Pure Oil Company's 8-D O. L. Swain 11, J. Walling survey, three miles northeast of Van in Van Zandt County, found the Buckner formation present from 11,545 to 11,680 feet. However, it entered the Eagle Mills salt at 11,680 feet and continued in it to a total depth of 11,686 feet, where it was abandoned on December 15, 1952.

Yantis Field: Humble Oil & Refining Company's Yantis Gas Unit 3, Well No. 6, in the Yantis field of Wood County, encountered Eagle Mills salt in contact with the Buckner formation.

Quitman Field: Shell Oil Company's Goldsmith 12, in the Quitman field of Wood County, encountered rock salt and anhydrite at a depth of 11,170 feet. The salt is in contact with the lower portion of the Schuler formation and represents a piercement-type salt dome rather than a fault contact.

Swain believes that there is conformity between the Smackover and the overlying Buckner formation. He calls attention to the offshore interfingering of anhydrite and evaporitic dolomitic limestones of the Buckner formation with oolitic limestones of Smackover type and suggests that the Smackover rocks were developed at the site of restrictive barriers that were a factor in the deposition of the evaporites.

Farther offshore, in Buckner time, there accumulated the fine-grained calcareous muds of the upper part of the dense limestone that forms the basinward facies of the Smackover. He assigns a Buckner age to the upper part of the more basinward Smackover. For example, he observed that oolites are scattered sparsely through the upper 750 feet of dense Smackover rocks encountered in Humble Oil & Refining Company's P. H. McKnight 1, W. R. James survey, in the Hawkins field of southeastern Wood County; this occurrence would suggest that some of the Buckner oolites were reworked seaward by wave action.

Piercement-Type Salt Domes. Recently the interior belt of piercement-type salt domes in the East Texas basin has drawn attention as hot spots. The Eocene Wilcox sandstone as well as the Rodessa sandstone of Lower Cretaceous age have proven to be new oil objectives off the flanks of these shallow domes.

Boggy Creek-Wilcox . . . A new oil objective for the East Texas basin was proven productive during September 1957 with the completion of a new shallow oil pay from the south flank of the Boggy Creek field of northeastern Anderson County.

H. R. Stroube and associates of Corsicana, W. T. Todd 1, located in the David Creek survey, Abst. 181, four miles northeast of the Neches townsite, pumped 40 barrels of low-gravity oil a day from Wilcox sandstone from 1475 to 1485 feet. Originally, this well was drilled to a total depth of 3536 feet, then plugged back to 1600 feet for completion.

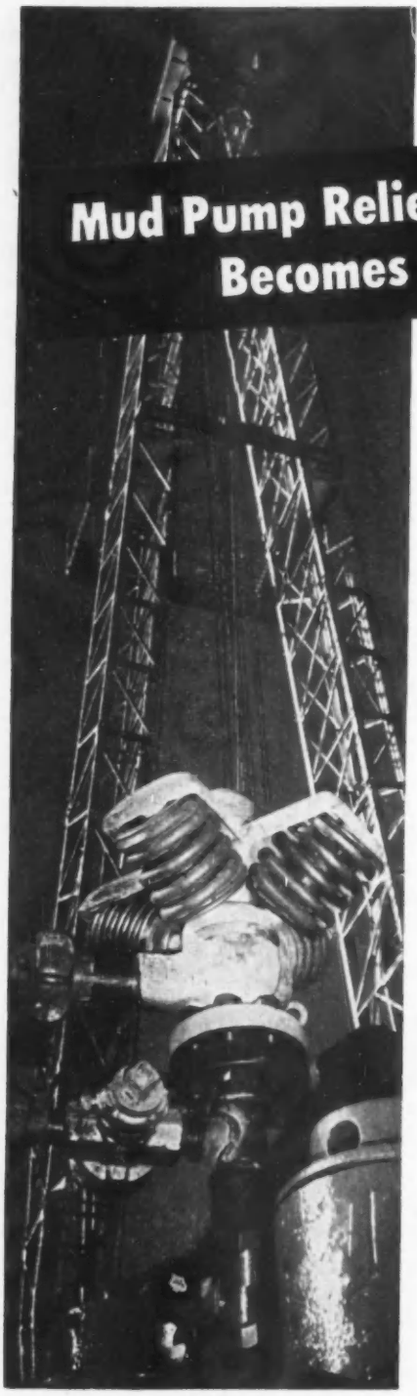
There is no other Eocene Wilcox sandstone production at present in the East Texas basin. The nearest oil field which produces from this formation lies 60 miles to the southeast in Angelina County.

Bethel-Woodbine . . . Woodbine sandstone oil production was discovered on July 6, 1956, on the northwest flank of the Bethel piercement-type salt dome beneath a salt overhang. The dome lies six miles northwest of the town of Tennessee Colony in Anderson County.

The discovery well was The Texas Company's E. C. Williams 2, located 1182 feet from the north line and 1115 feet from the east line out of a 405-acre tract in the Juan N. Acosta survey, Abst. 1. It was originally drilled to a total depth of 6101 feet. The 5½-inch oil string was set at 6000 feet. After it was perforated from 5622 to 5627 feet in the Woodbine formation, it was placed on the pump and produced 10 barrels of oil and 19 barrels of salt water per day.

Since the taking of this first potential, The Texas Company reworked the well and reperforated it from 5622-5630 feet. It was recompleted for 78 barrels of oil and 94 barrels of salt water per day on the pump.

In the drilling of this well, a section of 2873 feet of salt was penetrated in the overhang on the northwest flank from 1654 to 4527 feet. Woodbine shale was encountered from 5550 feet,



Mud Pump Relief Valve Importance Becomes More Critical

As mud pumps are necessarily operated at near capacity to meet the constantly increasing demands on drilling circulating systems, the safety demands on the relief valve become greater.

Responsibility for reducing hazards of personal injury, equipment damage and drilling trouble by relief of excessive drilling mud pressures, calls for a valve that assures positive instantaneous pressure relief at maximum volume and automatic restoration of circulation upon correction of the overloading condition. These requirements have been accomplished in the Kinzbach Model 112 Pressure Relief Valve by combining two unique methods of restraining the valve piston, yielding a characteristic action from a decreasing force against the valve piston on opening movement, and conversely, an increasing force during closure. This assures higher effective lift during valve action.

When excessive circulating pressures occur, the valve either repeats its cycle of rapid opening and closing, or remains open until the obstruction is removed or the pump stopped. Momentary blocks do not require pump shutdown to reset the valve. Movement of fluid may not be materially affected, preventing danger of stuck drill pipe as might occur with arrested circulation. Compounding Heads are available where pumps are used in series.

Kinzbach Model 112 Pressure Relief Valves are available in 2" and 3" sizes with pressures ranging from 500 psi to 16,500 psi. Write for complete data or consult your new Composite Catalog. Sold through Supply Stores everywhere.

KINZBACH TOOL CO INC

KINZBACH TOOL COMPANY, INC.

P. O. BOX 277 • HOUSTON, TEXAS

EXPORT OFFICE: 74 TRINITY PLACE, NEW YORK, N. Y.

and the objective Woodbine sand was logged from 5622 feet.

A syncline separates this unique Woodbine sand discovery from the nearest Woodbine sand production in the Cayuga deep-seated dome field only four miles to the northwest.

Bethel-Rodessa . . . A second and deeper hydrocarbon reservoir was discovered during August 1957 also beneath the salt overhang on the northwest flank of the Bethel dome. Seven miles northwest of Tennessee Colony, The Texas Company completed its E. C. Walton 1 in the T. H. Kingsley, Abst. 450, for an initial flow rate of 20.5 million cubic feet of gas and 430 barrels of 53°-gravity condensate per day. Shut-in tubing pressure registered 3425 psig.

Hainesville-Woodbine . . . The first piercement salt dome within the Mineola basin was proven productive from the Woodbine sandstone series beneath a salt overhang on the Hainesville dome, six miles northeast of the town of Mineola.

British-American Oil Producing Company's Bessie Weisenhunt 1, located 150 feet from the north line and 200 feet from the west line out of a 121.40-acre tract in the Wesley Tollett survey, Abst. 575, was completed on August 6, 1956, for an initial flowing potential of 259 barrels of 42 gravity oil per day produced through a ¼-inch tubing choke. Initial produced gas-oil ratio was 656 cubic feet per barrel of oil.

This well was drilled originally to a total depth of 11,490 feet, then plugged back and set 7-inch casing string at 10,764 feet. Completion perforations were made opposite the Woodbine sandstone series from 9217-22 and from 9228-47 feet.

In the original drilling of this well, a 52-foot section of anhydrite cap rock was cut before penetrating a 3887-foot section of salt from 1795 to 5683 feet. At the latter point, the drill entered the Taylor formation of Upper Cretaceous age. Austin chalk section was logged from 8442 to 8724 feet. The top of the Woodbine sandstone was found at 9215 feet.

REFERENCES

Swain, F. M., "Upper Jurassic of Northeastern Texas." *Bull. A. A. P. G.* vol. 33, no. 7 (July, 1949) pp. 1206-1250.

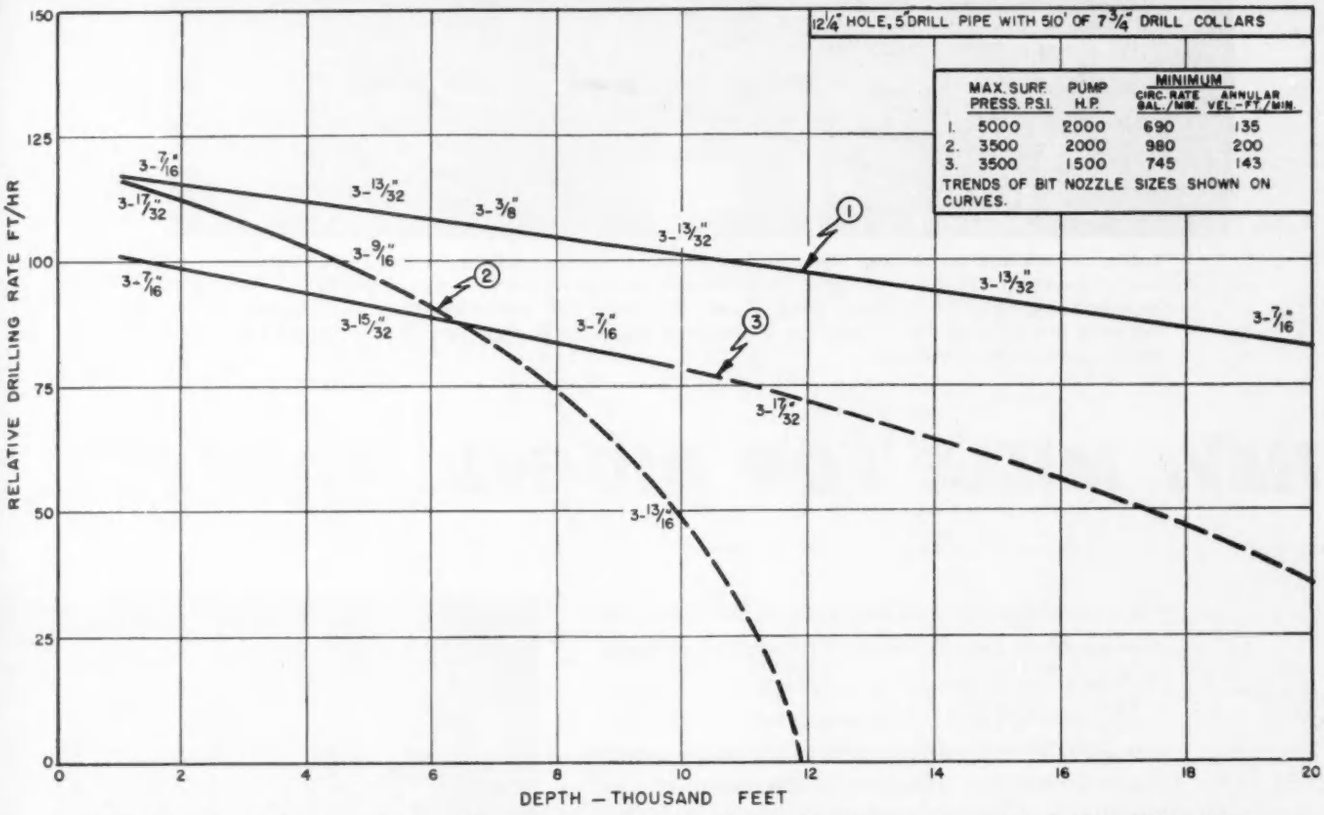

12¼" HOLE, 5" DRILL PIPE WITH 510' OF 7¾" DRILL COLLARS
MAX. SURF. PRESS. PSI. | PUMP H.P. | MINIMUM CIRC. RATE GAL./MIN. | MINIMUM ANNULAR VEL.-FT./MIN.
1. 5000 | 2000 | 690 | 135
2. 3500 | 2000 | 980 | 200
3. 3500 | 1500 | 745 | 143
TRENDS OF BIT NOZZLE SIZES SHOWN ON CURVES.
3-7/16"
3-17/32"
3-13/32"
3-3/8"
3-9/16"
3-15/32"
3-13/16"
3-17/32"
RELATIVE DRILLING RATE FT/HR
DEPTH — THOUSAND FEET

FIGURE 1—Effect of maximum allowable surface pressure on drilling rates at constant pump hp, optimum bit weights.

High Mud Pressures Increase Penetration

1500-hydraulic horsepower pumps have resulted in substantial increases in penetration rates at depths below 10,000 feet in South Louisiana.

By Ralph A. Watson, Humble Oil & Refining Company, Houston
and R. S. Sullins, Humble Oil & Refining Company, New Orleans

Increases in pump hydraulic horsepower from 500 to over 1500 have, with adequate bit weights, resulted in penetration rate improvements exceeding 100 percent in drilling 12¼ and 8⅝-inch holes in South Louisiana.

Further increases in drilling rates can be effected with pump output horsepower increased to 2000. Improved methods of generating cuttings are needed to take full advantage of the trend of increasing available mud pump horsepower. For proper power utilization during deep drilling, operating surface pressures of 5000 psi should accompany development of 2000 pump horsepower. Drill pipe diameter should not be less than 5 inches.

Hydraulic horsepower increases aid penetration rates with weighted muds as well as muds of normal weight. Loss of returns, more prevalent with heavier muds, may necessitate reduction in circulating rates and horsepower in some instances.

During recent years drilling rates generally have been improved by the combination of increased bit weights and hydraulic horsepower. In hard West Texas drilling, the benefits have been obtained from great increases in bit weight with less emphasis on hydraulic horsepower, as formations become more drillable greater hydraulic horsepower increases are necessary to gain the improvements possible with increased bit weights.

Formations penetrated in South Louisiana are predominantly of soft material and can be drilled rapidly.

Tubing stretch mill, Youngstown, Ohio. Electronically controlled mill to be completed during second quarter of 1958 . . . will provide increased production for Tubing comparable to our increased capacity for Casing. Both Upset Finishing Mill and this facility will greatly augment our existing No. 1 and No. 2 Seamless Mills in Youngstown. Photo shows mill building under construction.

NEW MILLS FOR BIGGER MARKETS

Two years ago, ground was broken for our three new seamless Pipe facilities. The express purpose of this massive expansion program was to make YOUNGSTOWN'S production capacity and seamless pipe product mix conform to the future needs of the Oil and Gas Industries. These seamless pipe facilities are now integrated with your demands. This means you can look to YOUNGSTOWN for a full line of Oil Country Tubular Goods without limitations as to size, grade or finish in Drill Pipe, Casing, Tubing and Line Pipe!

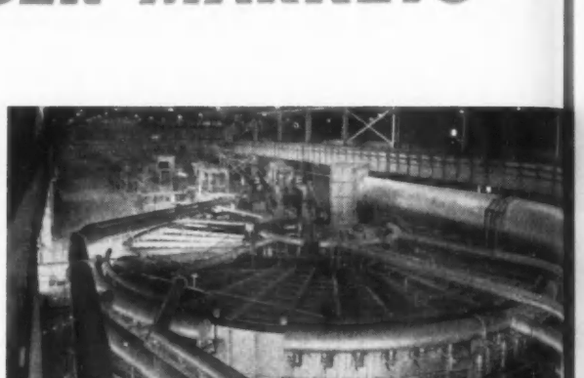
QUALITY YOUNGSTOWN SERVICE

YOUNGSTOWN

SHEET AND TUBE COMPANY

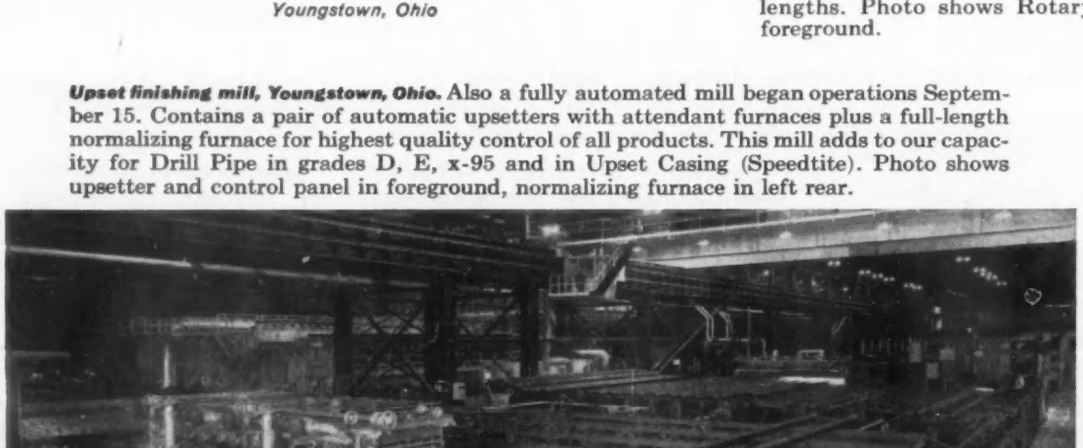
Manufacturers of Carbon, Alloy and Yoloy Steels

Youngstown, Ohio



No. 3 seamless mill, Indiana Harbor, Indiana. Fully automated, ultra modern mill . . . began operating September 30. Contains world's largest Rotary Billet Heating Furnace . . . adds to our over-all capacity in both alloy and carbon casing. Offers API casing in sizes 4½", 5", 5½" and 7", in grades H-40, J-55, N-80, in ranges 2 and 3 . . . plus line pipe in sizes 4½", 5$\frac{9}{16}$" and 6$\frac{5}{8}$" O.D. in grades A, B, X-42, A106, A53 in single and double random lengths. Photo shows Rotary Furnace in foreground.

Upset finishing mill, Youngstown, Ohio. Also a fully automated mill began operations September 15. Contains a pair of automatic upsetters with attendant furnaces plus a full-length normalizing furnace for highest quality control of all products. This mill adds to our capacity for Drill Pipe in grades D, E, x-95 and in Upset Casing (Speedtite). Photo shows upsetter and control panel in foreground, normalizing furnace in left rear.



In these formations, bit weights which can be carried are usually limited by the ability of the hydraulic system to keep the bit clean and to remove bit cuttings from the hole. In the past, drilling rates with low hydraulic horsepower appeared to be adequate; recent experiments with increased mud pump horsepower have shown that with adequate bit weight, penetration rates increase markedly.

This article is composed of (1) the theoretical application of 2000 hydraulic horsepower to rotary drilling and (2) the actual field experiences in utilization of 1500 and less hydraulic horsepower, the discussion has been divided in two parts.

THEORETICAL APPLICATION

Surface Pressure Requirements

The increase of pump hydraulic horsepower does not mean that drilling rate will be increased; even though ample bit weight is provided, a well's hydraulic system may be such that added horsepower is dissipated as friction loss. Analysis is required to determine how added hydraulic horsepower can best be utilized. The main factor affecting efficient use of horsepower, as depth increases, is the maximum working surface pressure which can be utilized. Increases in horsepower after maximum pressure has been reached can only be accomplished by increasing circulating rate with accompanying increases in bit nozzle size. There is a certain optimum nozzle size and circulating rate for best operation at a given pressure and benefits from increased horsepower become less as these values are exceeded, the loss becoming more pronounced as depth increases. A depth may be reached where relative drilling rate at increased pump horsepower and circulating rate at a certain maximum pressure will be less than at lower horsepower operation at optimum circulating rate and nozzle size.

Optimum circulating rates and nozzle sizes, for most efficient use of hydraulic horsepower, are governed by the friction losses in the hydraulic system of a well and will vary with well depth and mud characteristics. Any deviation from optimum conditions will result in a reduction in efficiency of cuttings removal at the bit.[1]

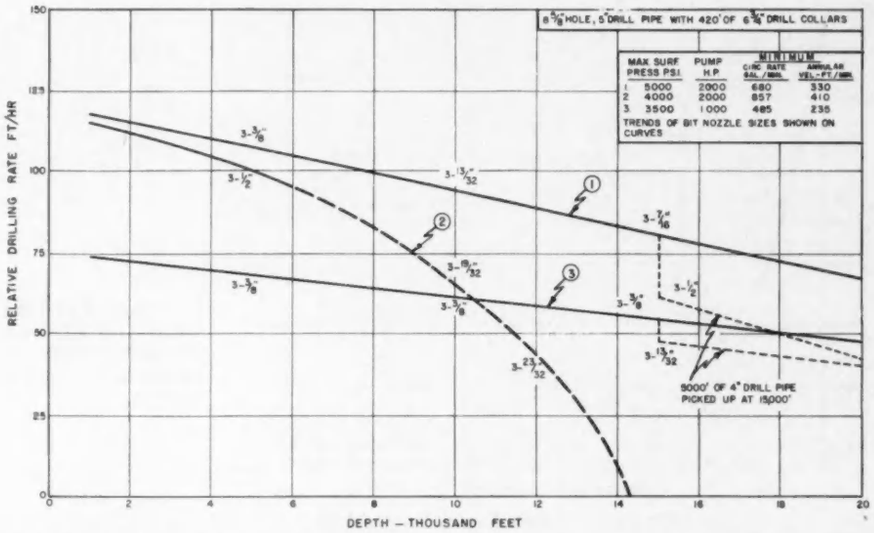


FIGURE 2—Effect of maximum allowable surface pressure on relative drilling rates at constant pump horsepower and optimum bit weights.

Relative Drilling Rates. The relation of drilling rate to well depth for various constant pump horsepowers and allowable working pressure for a 12¼-inch hole with 10 pounds per gallon, 3-centi poise mud is shown in Figure 1. With actual South Louisiana drilling conditions, the relative drilling rate at 11,000 feet, with 3500 psi surface pressure and 1500 hp., is 75 feet per hour. The dotted sections of the curves indicate that for these depths greater than optimum circulating rates and nozzle sizes were required to maintain constant horsepower, at the allowable surface pressure. Note that relative drilling rate decreases rapidly over these sections as depth increases. Assume that pump horsepower is increased above 1500, but that surface pressure cannot be raised above 3500 psi, the curves show a relative drilling rate of 30 feet per hour for 2000 hp, compared with 75 feet per hour for 1500 hp. at 11000 feet. When a 5000 psi allowable surface pressure is assumed, a curve of maximum efficiency is obtained at 2000 hp with an indicated relative drilling rate of 99 feet per hour at 11,000 feet. This is a 32 percent increase over the rate with 3500 psi and 1500 hp. A higher than 5000 psi surface pressure with 2000 hp in a 12¼-

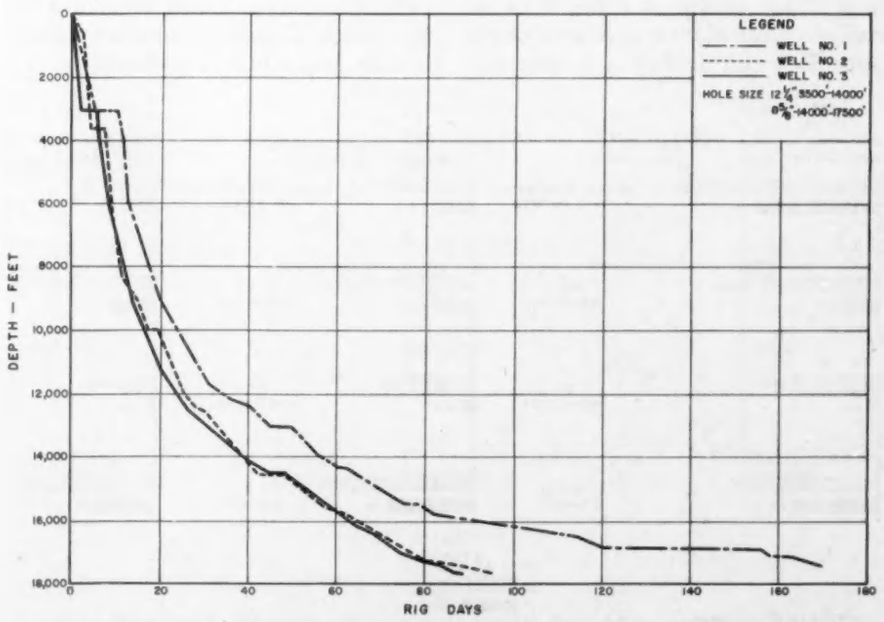


FIGURE 3—Field well drilling experience—depth vs. days—South Louisiana Field I.

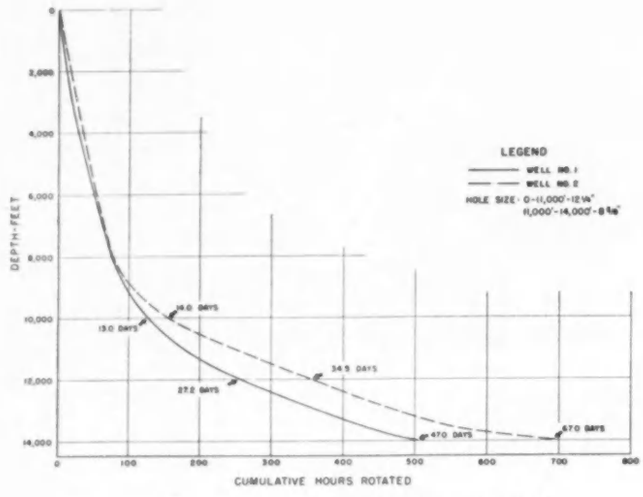


FIGURE 4—Field well drilling experience—depth vs. cumulative hours rotated.

South Louisiana Field II.

inch hole would result in annular velocities in the low range at 11 feet per minute and bit nozzles impractically small.

Figure 2 shows a similar family of curves for relative drilling rates in 8⅝-inch hole for various constant pump horsepowers and maximum allowable surface pressure based on 10 pounds per gallon, 3 centipoise mud. Relative drilling rates decrease with depth due to increase in friction losses. Dotted portions of the curves are sections for which greater than optimum circulating rates were used in order to maintain constant horsepower, thus accelerating losses. The curves indicate that with surface pressure limited at 3500 psi, efficient operations can be carried on to 20,000 feet with 10 pounds per gallon mud, maintaining 1000 hydraulic horsepower at the surface. If an attempt is made to materially increase the horsepower with the same 3500 psi, or slightly greater surface pressure, increased relative drilling rates are obtained only in the shallower hole section. The effect of increased friction losses are even more pronounced than in 12¼-inch hole. Figure 2 illustrates that to properly utilize 2000 hydraulic horsepower to depths below 16,000 feet in 8⅝-inch hole a surface pressure of 5000 psi is needed. The relative drilling rate at 16,000 feet will be approximately 79 feet per hour as compared to 55 for the 1000 hp, 3500 psi operation.

Annular Velocities. Annual velocities of 330 feet per minute, as with 5000 psi pressure should be quite adequate to remove cuttings. Annular velocities at lower pressures with 2000 hp may be excessive. Optimum nozzle sizes, indicated in Figure 2, are in the range from ⅜ to ½ inch for efficient operation at either 1000 or 2000 hp; nozzle plugging frequency should not be great, but care should be exercised in making trips to control swabbing or pressure surges.

Drill Pipe Requirements. The dotted additions to the right-hand portions of curves 1 and 3 in Figure 2 indicate the effect of placing a 5000-foot section of 4-inch drill pipe in the drill string after reaching 15,000 feet depth to stimulate operation with 5-inch pipe of tensile strength insufficient for drilling with a full string below that depth. The resulting reduction in relative drilling rate is quite small for the 1000-hp curve, while when developing 2000 hp the drilling rate reduction is of such magnitude as to show only a slight gain in relative drilling rate due to the 1000 hp increase at the surface. In order to regain drilling efficiency at 2000 hp with such a tapered string, pressures above 5000 psi would be required; also excessively small bit nozzles would result. For the operation under consideration, 5-inch drill pipe should be used with sufficient tensile rating to allow running a full string, to prevent increased friction losses due to decreased inside pipe diameter.

Effect of Increasing Mud Weight. In wells requiring mud weight above 10 pounds per gallons, the relative drilling rate at given surface hydraulic horsepower and pressure conditions is reduced in inverse proportion to the mud weight increase. The effect is that of operating at surface horsepower and pressure reduced in accordance with mud weight increases. For example, optimum circulating rates for operation with 14.3 pounds per gallon mud at 5000 psi and 2000 hp surface conditions, would be the same as for 10 pounds per gallon mud with 3500 psi and 1400 hp. In a 12¼-inch hole, variation of relative drilling rate with depth would approach that of curve 3 in Figure 1, optimum circulating rates could be maintained to 12,000 feet without reducing horsepower, nozzle diameters being 3—15/32 inch against 3—13/32 inch for 10 pounds per gallon mud at that depth.

Assuming 3500 psi and 1500 hp at the surface with 14.3 pounds per gallon mud, optimum conditions in 12¼-inch hole would be equivalent to 2450 psi and 1050 hp. Relative drilling rate from curve 3 in Figure 1 is 70 feet per hour at 12,000 feet for 10 pounds per

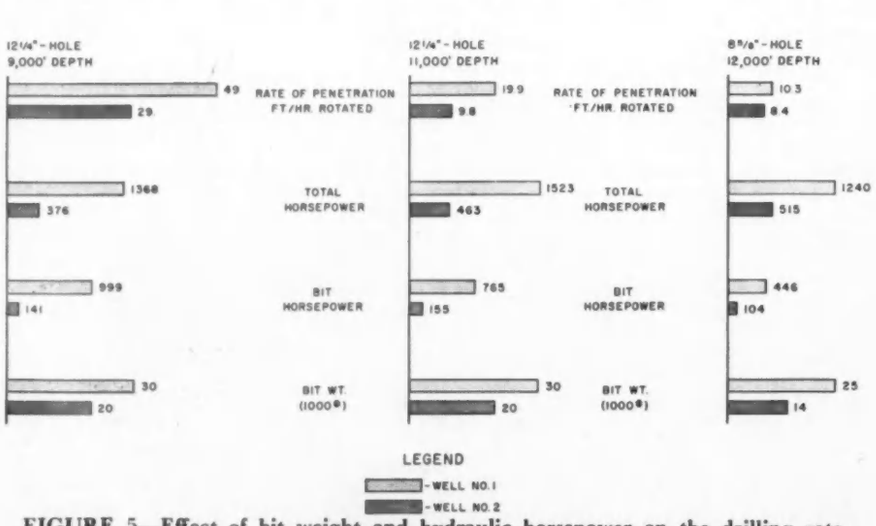


FIGURE 5—Effect of bit weight and hydraulic horsepower on the drilling rate. South Louisiana Field II.

gallon mud whereas for 14.3 pounds per gallon mud it is 38 feet per hour. Utilizing 5000 psi and 2000 hp with 14.3 pounds per gallon mud, the relative drilling rate is brought up again to 70 feet per hour. This indicates an advantage in operating with the high horsepower and pressure even though abnormal pressures are encountered.

Nozzle size also becomes greater for optimum operation at given horsepower and pressure as mud weight increases. Conditions may develop in the hydraulic system with which an increase in mud weight will require a reduction in hydraulic horsepower to maintain optimum operations. The higher the allowable surface pressure the deeper a hole can be drilled before such a point is reached.

A stage is often reached, during the increasing of mud weight, at which mud is lost to the formation unless circulating rates are greatly reduced to minimize pressure on incompetent zones. When such is the case, pump horsepower and drilling efficiency must be sacrificed. Bit nozzles usually cannot be reduced at such times to increase pump pressure and horsepower, since resultant accentuated pressure surges while making trips might contribute toward breaking down the formation.

FIELD EXPERIENCE

It is realized that 2000 hydraulic hp has not yet been used in the field; however, 1500 to 1600 hp has been employed in the drilling of several wells in South Louisiana in fields where alkaline tannate oil emulsion muds are used ranging in weight from 10 to 11 pounds per gallon.

Illustrated in Figure 3 is drilling experience in a South Louisiana field, designated as Field I, where wells were drilled to 17,000 feet with similar mud properties, hole sizes, and casing setting depths, by one operator during a recent two-year period. The essential difference in drilling conditions was that of hydraulic horsepower available and utilized. A reduction of 40 percent in the number of days required to reach 17,000 feet was experienced in the drilling of the more recent Wells 2 and 3 compared with Well 1. Well 1 was drilled with a surface hydraulic horsepower of approximately 500 as compared with approximately 1000 in the drilling of the more recent wells. With the increase in hydraulic horsepower, increased bit

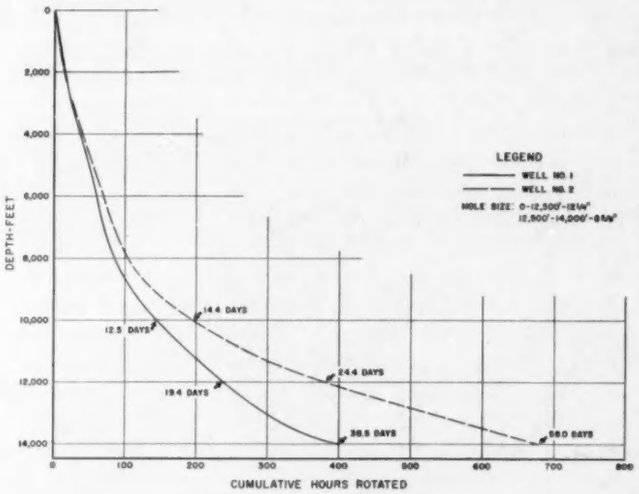


FIGURE 6—Field well drilling experience—depth vs. cumulative hours rotated.

South Louisiana Field III.

weights could be employed and the combination of the two is responsible for improved drilling experience. Pump pressures were maintained at approximately 1700 psi in the first well and at from 2600 to 2800 psi in the drilling of the more recent wells. As a result of the material improvement in drilling experience, further increases in pump pressure and hydraulic horsepower were made in an attempt to obtain further improvement in drilling rate. Increases of pump pressure to 3500 psi and hydraulic horsepower to 1500 were possible with the drilling equipment available on the rig. Drilling operations at the 1500 hp value have been carried on in other areas in South Louisiana.

Drilling experience in another South Louisiana field, designated as Field II, is shown in Figure 4, comparing results of a rig with 1500 hydraulic horsepower, Well 1, with those obtained while drilling with another rig with approximately 500 hydraulic horsepower, Well 2, in the same field. This comparison indicates that at a depth of 10,000 feet there is an advantage of one day favoring greater horsepower when comparing the 1500 hydraulic horsepower operation with the 500-hp operation. At a depth of 12,000 feet, the advantage in favor of the greater horsepower had increased to 7.3 days, and at 14,000 feet there was a 20-day advantage or 190 hours rotated indicated for the 1500 hp operation. It is apparent that the 500 hydraulic horsepower rig did not remain competitive at depths below 10,000 feet.

A bar graph (Figure 5) has been prepared to illustrate the effect of bit weight and hydraulic horsepower on drilling rate for these two rigs in Field II. This graph illustrates (1) rate of penetration, (2) total hydraulic horse-

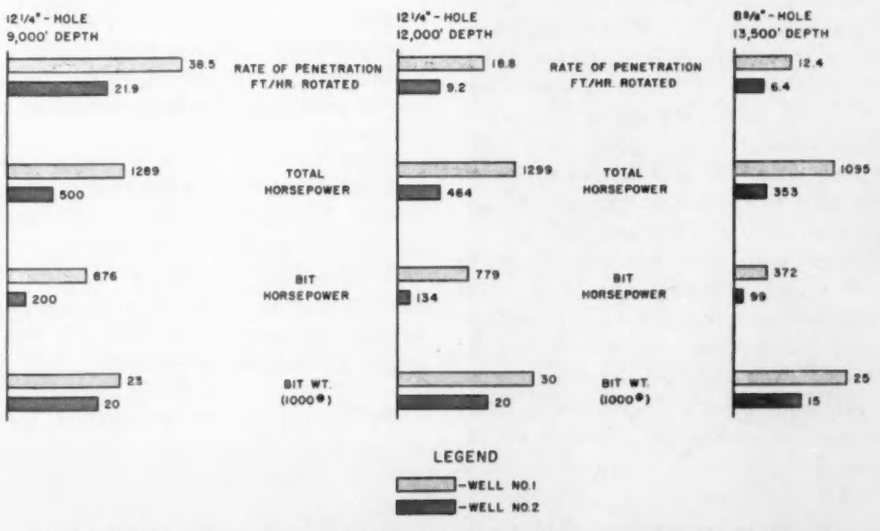


FIGURE 7—Effect of bit weight and hydraulic horsepower on drilling rate. South Louisiana Field III.

power, (3) bit horsepower, and (4) bit weights for the two rigs at depths of 9000; 11,000; and 12,000 feet.

Further study of 1500 hydraulic horsepower vs 500 hydraulic horsepower was made with two rigs in a South Louisiana field, designated as Field III, since conclusion of drilling in Field II. As illustrated in Figure Figure 6, this study indicates that at a depth of 10,000 feet there is an advantage of 1.9 days when comparing the 1500 hydraulic horsepower operation, Well 1, with the 500-hp operation, Well 2; at a depth of 12,000 feet, the advantage in favor of the greater horsepower had increased to 5.0 days; and at 14,000 feet, there was a 19.5 day advantage, or 275 hours rotated in favor of the 1500-hp operation. Again, it is apparent that the 500 hydraulic horsepower rig did not remain competitive at depths below 10,000 feet. A bar graph, Figure 7, has been prepared to illustrate the effect of bit weight and hydraulic horsepower on drilling rate of these two rigs at depths of 9000; 12,000; and 13,500 feet. Greater horsepower, combined with the greater bit weights, results in increased penetration rates. For the depth intervals illustrated, the penetration rate increase ranged from 76 to 104 percent for the 1500 hydraulic horsepower rig when compared with the 500 hydraulic horsepower rig.

Field data examined from 39 wells in South Louisiana, where the surface hydraulic horsepower varied from about 150 to 1500, and the drilling rate, while drilling a 12¼-inch hole from 10,500 feet to 11,000 feet, was determined. There was a definite trend showing the increased drilling rate with increased surface horsepower. Reasonable agreement between theoretical and field results was obtained although operating conditions varied widely. The data indicated that still further increases in drilling rate could be expected by going to 2000 surface hydraulic horsepower with increase amounting to about 12 percent. This field data demonstrates that there are many factors, other than surface hydraulic horsepower, effecting the rate of penetration in deep wells in South Louisiana fields. Careful planning of the entire operation is required to obtain maximum benefit.

Operation at higher hydraulic horsepower does not result in a solution to all of the drilling problems occuring at depths. A review of past experience indicates that the higher hydraulic horsepower is of particular advantage in South Louisiana deep drilling. The increase in relative drilling rate obtained by using the higher hydraulic horsepower will be reduced if it is necessary to use weighted muds, or if throttled pump operations are required because of lost returns.

Problems resulting from operating conditions of 1500 hydraulic horsepower and 3500 psi pump pressure have essentially been eliminated. With a hydraulic horsepower of 2000, it is probable that many new problems will arise; the fluid end of the pumps, as well as portions of the circulating system will require redesigning to withstand 5000 psi for operation in either parallel or compound. An increase of 31 percent, or $15 per day per pump in the cost of pump parts occurred with an increase in hydraulic horsepower from 500 to 1500. It is probable that the cost of pump parts will again increase with further increases in hydraulic horsepower. The economic advantage to be attained by increasing horsepower from 1500 to 2000 is not as well defined as for increases up to 1500 hp but must be evaluated. The rotary system of drilling is essentially the generation of chips or cuttings by a cutting mechanism and their removal by a hydraulic system. The ability to generate cuttings has not kept pace with the increase in the capacity of the hydraulic systems available, and improved cutting tools are needed if maximum advantage is to be obtained.

Conclusion

Based on the results experienced in South Louisiana, Field I, II, and III, while drilling with hydraulic horsepower amounting to as much as 1500, the following conclusions have been made.

1. Reasonable agreement exists between theoretical data and field experience.

2. One thousand five hundred hydraulic hp has been used to an economic advantage when compared with operations where 500 to 1000 hydraulic horsepower was used.

3. Economic advantage with 1500 hydraulic hp is limited to operations when drilling with normal weight drilling fluids and with weighted muds where no lost circulation problem exists.

4. Increases from 1500 to 2000 hydraulic hp should allow an increase in drilling rate approximating 12 percent. Economic advantage attending this hp increase is not as well defined as for increases up to 1500 hp but must be evaluated in the field.

5. Further improvements in the pump and other surface equipment will be necessary before 2000 hydraulic hp can be efficiently used, since 5000 psi surface pressure must be maintained. Pump manufacturers should incorporate 5000 psi working pressure fluid ends in 1000-hp range pumps.

6. Improved methods of chip generation are needed to take maximum advantage of the higher hydraulic systems available.

7. Increases in pump hp will be of little benefit if adequate bit weights are not maintained.

8. Operating surface pressure above 5000 psi begin to lose signficant advantage for 12¼ and 8⅝-inch holes due to small bit nozzle sizes and/or low annular return velocities which would accompany.

9. In higher hydraulic horsepower systems available today, 5-inch drill pipe should be used since a reduction in size of only a portion of the string will tend to nullify gains in drilling rate from increased horsepower because of increased friction loss in the drill pipe. Suitable high yield strength 5-inch pipe should be made available by manufacturers to drill below 20,000 feet.

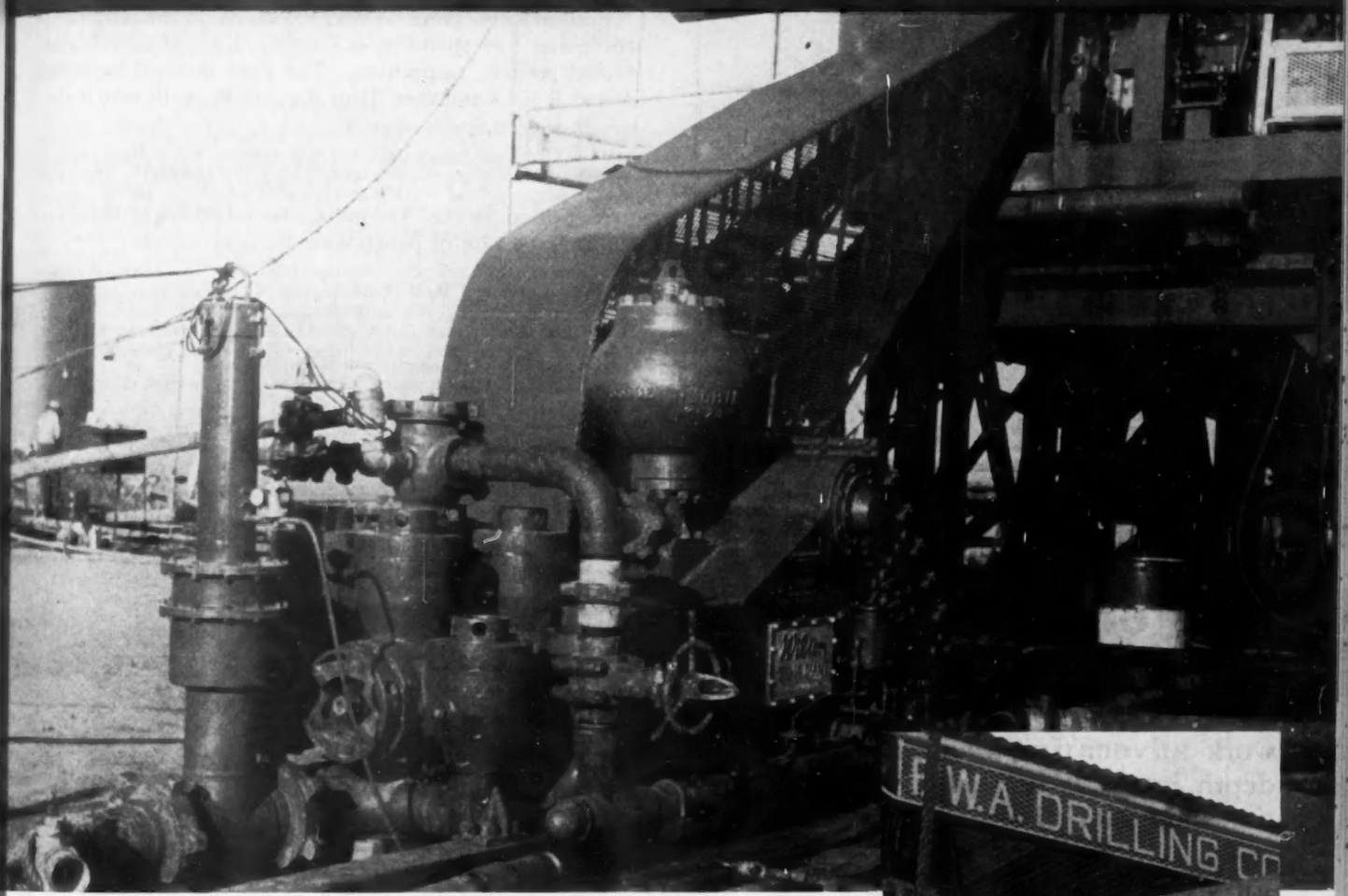
ACKNOWLEDGMENT

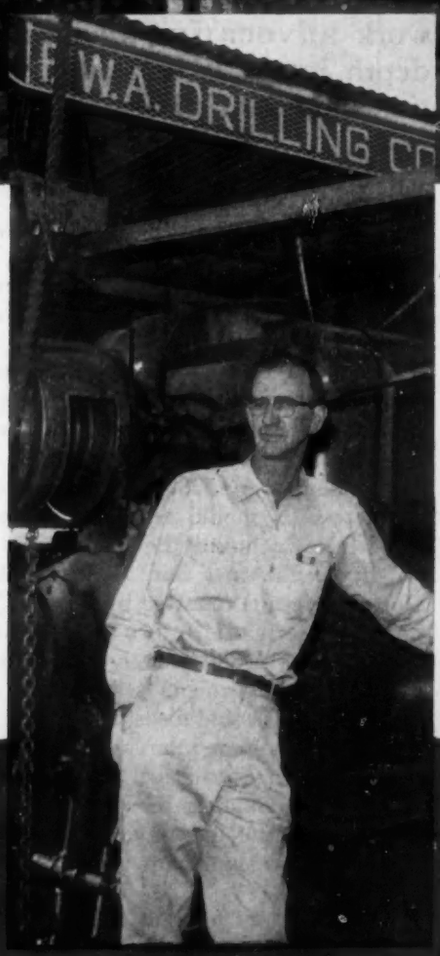
The authors thank the management of Humble Oil & Refining Company for permission to publish this article. They also thank AIME for releasing publication rights to WORLD OIL.

REFERENCE

[1] Eckel, John R., and Nolley, J. P. "An Analysis of Hydraulic Factors Affecting the Rate of Penetration of Drag-Type Rotary Bits." Spring Meeting of SW Dist. API Division of Production, Galveston, Texas, (March, 1949).

"A WILSON PUMP MEANS MORE HOLE at LESS COST with HIGHER EFFICIENCY..."





"...More Pressure per H.P. is the Reason why!",

states "Buster" Ligon, toolpusher for FWA Drilling Company.

Efficient operation is what every operator wants from his equipment. After *three years of field performance* the Wilson Giant Model Mud Pump, has an amazing record of PERFECT OPERATION and at extremely high efficiency. Mr. Ligon reports, "In continuous operation, with 1700 lbs. constant pressure at 75 strokes per minute we found no perceptible jerk in hose. It's the smoothest operating pump that our crews have ever used. It gives us a smooth steady flow of mud, which is extremely important while drilling. As for maintenance, we've had very little. It's a simple pump to work with because we can change valve inserts in 30 minutes, where we have taken as long as 2 to 3 hours on other pumps."

WHY NOT MAKE YOUR NEXT PUMP A WILSON?
For complete details on the Wilson Giant Mud Pump write for Bulletin 206.

BE MODERN—BUY WILSON

Wilson

WILSON MANUFACTURING CO., INC.
WICHITA FALLS, TEXAS, U.S.A.
The Home of RED IRON

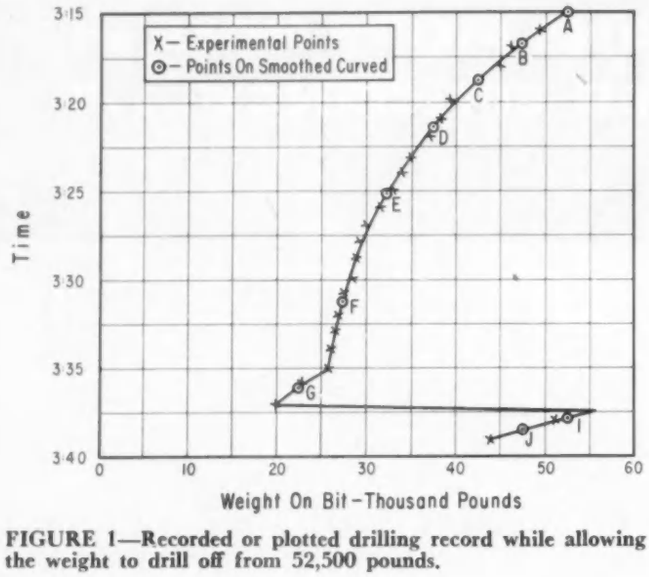


FIGURE 1—Recorded or plotted drilling record while allowing the weight to drill off from 52,500 pounds.

The Effects of Weight and Speed on Penetration

A discussion of AAODC committee work advocating the use of very short depth intervals to assure constant formation characteristics.

By Arthur Lubinski
Pan American Oil Corporation, Tulsa

THE DIFFICULTY of the study of weight/speed penetration resides in the fact that drilling characteristics of formations are generally changing from layer to layer. Rarely are the same characteristics encountered in successive two-foot intervals. And to obtain the rate versus weight law in some formation for a constant value of rpm and for weights varying from 30,000 pounds to 50,000 pounds by 5000-pound increments, the formation characteristics should remain the same over an interval of 12 feet (including the last interval run with the same weight as the first one). This explains the enormous scatter of results reported by Woods. The method he proposes to use in the future is appreciably better. It consists of carrying alternately two weights only. This will require a homogeneous section of 6 instead of 12 feet. With care one could measure the rate of drilling over one instead of two-foot intervals and thus reduce the above-mentioned 6 feet to 3 feet. But even the results of such a method are bound to present a great scatter, and a very large number of measurements will be needed to arrive statistically at significant results.

The purpose here is to propose a method which should permit determination of an entire rate versus weight curve over a very short interval, generally of a few inches. The method consists of either recording, or reading and plotting, weight versus time during drilling-off periods. Figure 1 shows such a hypothetical plot. In order to correct for experimental errors, a smooth curve is drawn through experimental points.

Consider now points A and B located on the smoothed curve and corresponding to weights on bit of 52,500 and 47,500 pounds, respectively. The time interval between A and B is 1.8 minutes. Thus the rate R_w with which the weight is dropping is equal to:

$$R_w = \frac{52{,}500 - 47{,}500}{1.8} = 2{,}777 \frac{\text{lb.}}{\text{min.}} = 166{,}600 \frac{\text{lb.}}{\text{hr.}}$$

As proven in the Appendix, the relationship between R_w and the rate of penetration R_p is as follows:

$$R_p = L \times \frac{1}{EA} \times R_w \qquad (1)$$

in which

R_p is the rate of penetration in feet per hour.
R_w is the rate with which the weight on the bit is decreasing in pounds per hour.
E is the Young modulus of steel: $E = 30 \times 10^6$ psi.
A is the cross-sectional area of drill pipe wall in square inches.
and L is the length of drill pipe in feet.

For 4½ inches — 16.6 pounds per foot drill pipe, A is equal to 4.407 square inches. Consider that the results of Figure 1 were obtained with a length of drill pipe equal to about 10,000 feet. Then Equation (1) becomes:

$$R_p = 76 \times 10^{-6} \, R_w \qquad (2)$$

Thus for the interval AB the rate of drilling is:

$$R_p = 76 \times 10^{-6} \times 166{,}600 = \underline{12.7 \text{ feet per hour}}$$

which corresponds to an average weight on bit of 0.5 (52,500 + 47,500) = 50,000 pounds.

In Figure 2 is plotted the rate versus weight. Point P (50,000 pounds, 12.7 feet per hour) represents the result so far obtained from the hypothetical record, Figure 1. Repeating the same calculations for intervals BC, CD, DE and EF, the rates of penetration in the investigated formation for weights on bit of 45,000, 40,000, 35,000 and 30,000 pounds are obtained and plotted in Figure 2 at Q, R, S and T.

Each value of the rate of penetration is thus measured over a very short depth interval ΔL which, as shown in the Appendix, may be calculated as follows:

$$\Delta L = L \times \frac{1}{EA} \times \Delta W \qquad (3)$$

in which ΔW is the drop of weight in pounds in the depth interval. ΔL in feet. For 4½ inches — 16 pounds per foot drill pipe and a 10,000-foot length of drill pipe, (3) becomes:

$$\Delta L = 76 \times 10^{-6} \, \Delta W \qquad (4)$$

Thus for intervals ΔW of 5000 pounds, we obtain:

$$\Delta L = 76 \times 10^{-6} \times 5000 = 0.38 \text{ feet} = 4.56 \text{ inches}$$

ΔL would even be smaller at depths shallower than 10,000 feet used in the example.

From the above it is seen that in the proposed method the rate of drilling is measured over very short depth intervals, thus greatly increasing the probability that formation characteristics will remain constant. Therefore, the number of experiments could be much smaller than with the presently used technique. The results

should be obtained faster and at less expenditure.

Another advantage of the proposed method is that changes in formation characteristics are seen in the record. For instance, in the hypothetical record, Figure 1, a much softer formation was encountered at 3:35, i.e. between points F and G. Thus one may reject from consideration intervals, such as FG, containing a formation change. After such a change, one may immediately use the intervals which follow, such as IJ, to investigate the rate-versus-weight law in the newly encountered formation.

APPENDIX

Figure 3 is a diagram of force in the drill pipe versus depth. AA_1 represents the tension in the string at the surface, BB_1, the tension at depth B, etc. The neutral point is at C. At the depth D, the string is under compression DD_1. Finally at the lower end of drill pipe the compression is FF_1. For the sake of simplicity, no drill collars are considered, the conclusion which will be reached being independent of the presence of collars. Consider now that a weight ΔW has been drilled off. The corresponding situation is indicated with a dashed line. The tension at the surface is now AA_2 (A_1A_2 representing ΔW), the tension at the depth B increased from BB_1 to BB_2. At C, zero tension increased to a tension CC_2. At D the compression DD_1 became nil. And finally at F the compression FF_1 decreased to the value FF_2. From inspection of Figure 3, it is seen that at any point, either the tension increased by ΔW, or the compression decreased by the same amount ΔW, or the compression became tension, the total change being again ΔW. An increase of tension has the same effect on elongation as an equal decrease of compression. Therefore, as far as elongation is concerned, the system of Figure 3 is equivalent to that of Figure 4, which represents a pipe, at the bottom of which a tension ΔW is applied. The corresponding elongation ΔL, obtained from Hooke's law is Equation (3), previously considered.

Taking the derivative with respect to time of ΔL and ΔW in Equation (3), Equation (1), previously considered, is obtained.

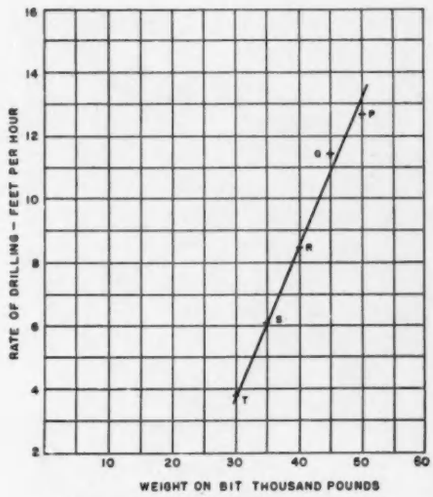


FIGURE 2—Rate versus weight curve corresponding to interval A-F in Figure 1.

ACKNOWLEDGMENT

This information was prepared as a discussion of the paper "Progress Report on the Weight/Speed Penetration Study" by Elmer Decker, H. B. Woods and D. S. Rowley and presented on October 15, 1957, at the AAODC Annual Meeting in Tulsa.

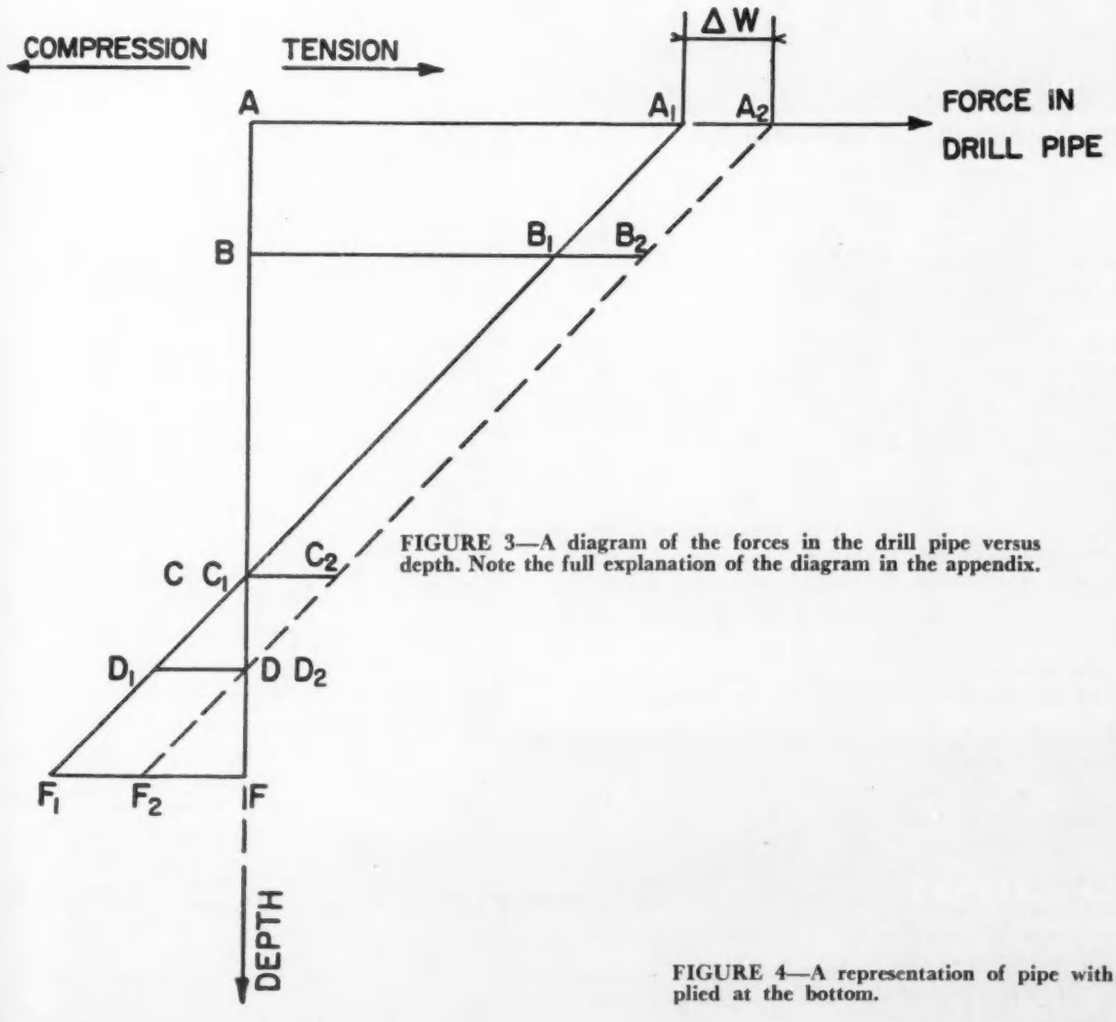


FIGURE 3—A diagram of the forces in the drill pipe versus depth. Note the full explanation of the diagram in the appendix.

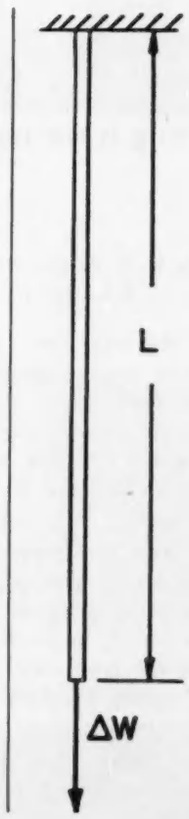


FIGURE 4—A representation of pipe with a tension load applied at the bottom.

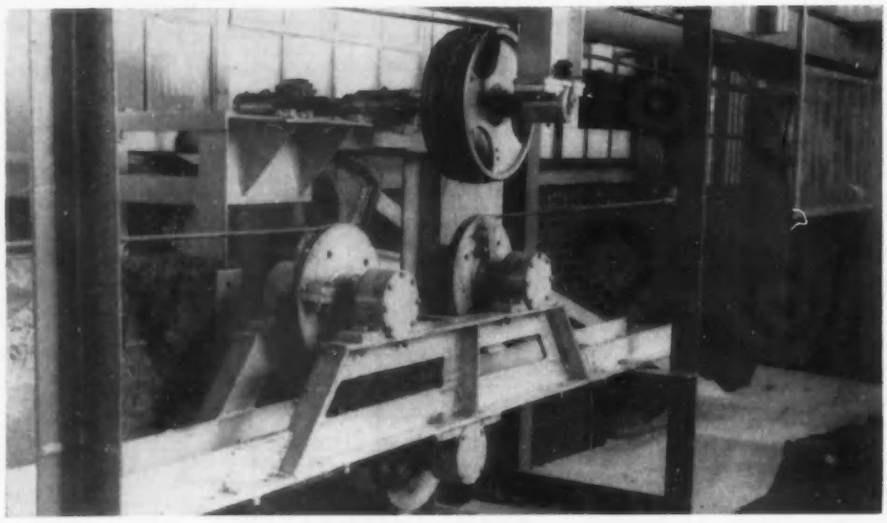


FIGURE 1—The destructive method was used in testing the wire rope. The machine shown here is the fatigue machine used in the tests.

Wire Rope Is a Machine And Needs Maintenance

Next to lubrication, proper handling and operating is the most important consideration.

By C. E. Bogle and C. T. Evenden
Jones & Laughlin Supply Company, Tulsa

As HAS BEEN the experience of most worthwhile undertakings, which in case dates back many years, a small group realized the need for combined ideas and unifying efforts in an attempt to improve wire rope service.

You no doubt have heard the expression "wire rope is a machine"—a special purpose machine. Wire rope is merely a medium of transmitting power from one form into another. Properly handled and cared for, you can expect maximum wire rope life.

If wire ropes are to give the service of which they are capable, attention must be given to maintaining them in proper condition. The proper lubrication is a most important job in realizing maximum life. We realize that lubrication is a significant structural part of all wire rope manufactured. Believing this, we directed our efforts toward finding out the exact benefits obtained from lubrication.

A series of tests was conducted on a fatigue machine, which is normally referred to as a destructive method of testing wire rope. (See Figure 1.)

This machine is designed to take sheave diameters comparable to the recognized sheave to rope ratios as set forth in the API Bulletin PR-9B. The rope is attached to a hydraulic jack on one end and to standard industrial scales on the other end. Any given load can be applied by merely pumping the hydraulic jack. The rope oscillates back and forth over the sheaves, subjecting it to two reverse bends with each completion of the cycle. The results of a series of tests are:

Dry rope. . . . . 18,000 reversals.

Lubricated rope. 23,500 reversals.

Figure 2 shows a dry rope operated at one-fifth the breaking strength of the rope after 18,000 reversals. The same type failure is encountered when running lubricated rope, only it occurs after 23,500 reversals. This proves conclusively that the proper lubrication is a most important consideration.

The correct lubrication of wire rope should be with a lubricant having the following essential characteristics: adhesiveness to metal, high film strength, water repellent, corrosion prevention, compounded stability, heat resistance and sealing of the rope to prevent infiltration of foreign substances to the strands and core. The greatest factors contributing to short life in wire rope are abrasion, frictional wear and corrosion.

Lubrication. Although lubricants are applied as a structural part of nearly all wire ropes during manufacture, ropes must be lubricated periodically or the rope will fail long before its normal lifetime. Ropes that run in the hole where the hole contains salt or alkaline water will result in rapid and excessive corrosion, and in corrosion fatigue. Periods of idleness between drilling jobs likewise allow this condition to develop, unless lines are lubricated for protection. Cold lubricant can be applied by pouring it on the rope, then use swab to spread evenly and remove excess.

To obtain maximum wire rope life, perhaps the most important consideration, next to lubrication, is the proper handling or operating on the job. When wire rope is reeved in multiple parts to transmit power to a load, as in rotary drilling, the stress in the rope depends on the number of rope parts. The lead line to the drum contains the highest tension or stress when a load is being raised, because

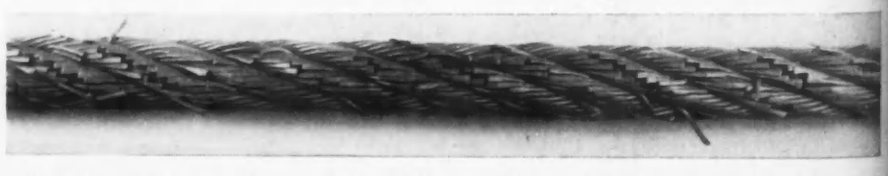


FIGURE 2—After 18,000 reversals the dry rope shown here broke at only 1/5 of the breaking strength of the rope.

keep 'em turning
to the right . . .

with quality engineered

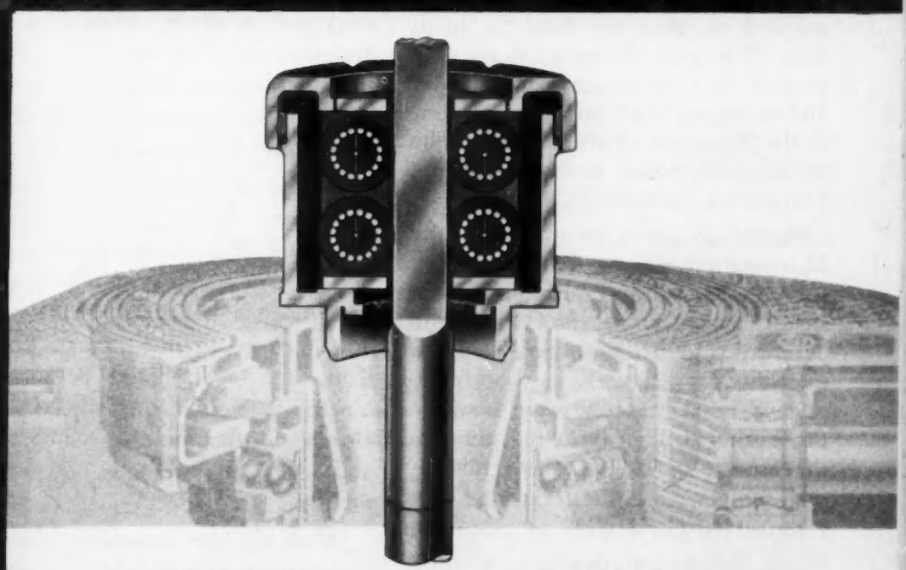
BAASH-ROSS
ROLLER KELLY DRIVE BUSHINGS

Precision engineered and ruggedly constructed, Baash-Ross roller kelly drive bushings always operate smoothly and efficiently under extremes of torque and rotary speeds.

Key feature of this bushing is the assembly of tandem rollers—in both square and hexagonal models—with eight or twelve large diameter rollers, with non-friction bearings, in constant positive contact with the kelly faces. Kelly wobble is prevented and stability is assured.

Since the rollers always provide smooth, friction-free feeding, weight indications are accurate; damaging impacts to drill string and other equipment can be avoided.

Superior performance has made Baash-Ross kelly drive bushings preferred in the industry. For additional information write to P. O. Box 1348, Houston 1, Texas, or see the Composite Catalog.



Individually lubricated rollers rotate on precision roller bearings.

BAASH-ROSS TOOL COMPANY

DIVISION OF JOY MANUFACTURING COMPANY

GENERAL OFFICES: 5306 CLINTON DR., HOUSTON, TEXAS

AREA OFFICES:

Houston, Texas; Odessa, Texas; Dallas, Texas; Long Beach, Calif.; Denver, Colo.; Oklahoma City, Okla.; Olney, Ill.; Mexico City, Mexico; Edmonton, Alberta, Canada.

FOREIGN OFFICES:

New York, N. Y.; Greenock, Scotland; London, England; Paris, France; Maracaibo, Venezuela; Buenos Aires, Argentina.

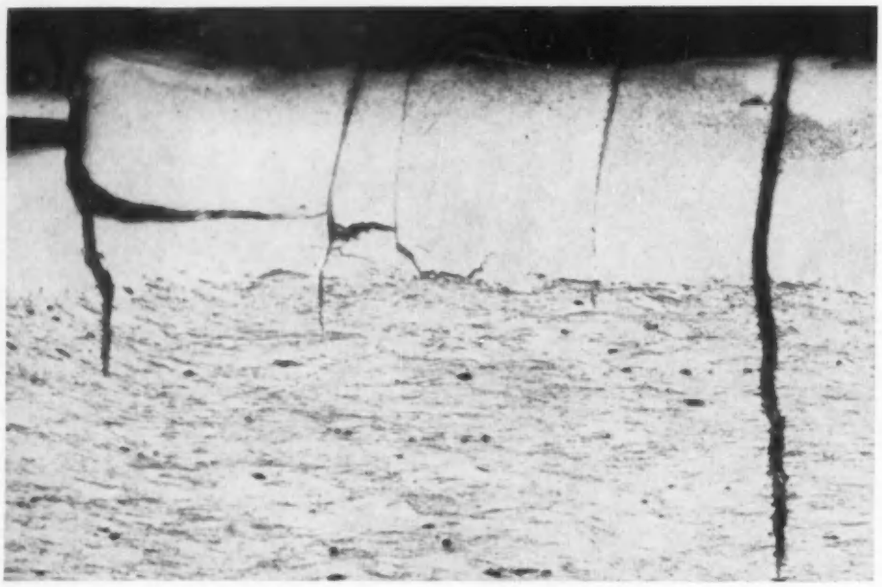


FIGURE 3—The Martensitic structure shown here is formed by the minute high temperature caused by the abrasion of the line in use.

C. E. (ED) BOGLE was graduated from Southwestern Missouri State in 1935. Prior to service in World War II he was with Addressograph Corporation. Following the war he was associated with Mid-Western Engine & Equipment Co., Tulsa, and Jones & Laughlin Steel Corp. He joined Jones & Laughlin Supply Division this year as manager, wire rope sales.

•

C. T. EVENDEN, sales service engineer with Jones & Laughlin, has been in the wire rope industry for 20 years. He holds a degree in aeronautical engineering from California Institute of Technology.

it not only takes its portion of the load lifted, but the additional stress necessary to overcome friction in the sheave bearings. The greater the number of parts, the greater becomes the stress necessary to overcome friction, and, consequently, the lower becomes the efficiency of the system.

When applying the load, "jerks" and "jackrabbit" starts should be avoided as they are fatal to many lines. This type of starts causes skidding of the rope on the crown sheaves and traveling block sheaves, resulting in the formation of a microscopic film of steel, or what is commonly referred to as "Martensite."

Figure 3 shows very clearly this Martensite structure. The micro-constituent, Martensite, developed when steel is heated above the critical temperature (1425° F.) and rapidly quenched, is extremely hard and brittle and cracks readily when bent. In the case of drilling lines, it is thought that severe abrasion causes minute, high-temperature points to be developed on the surface of the outer wires; the rapid cooling of these points by the surrounding metal causes Martensite to be formed. The surface area of a Martensite film has been found to be very small and the depth varies from a trace to 0.002 inches. The flexing and bending of the wire, as it passes over the drum or sheaves, causes the film to crack; the cracks act as notches, creating stress concentrations which lead to early fatigue failure of the wire. As a result, surface Martensite, rather than straight fatigue, has been found responsible for a lot of outer wire failures.

Martensite is more likely to be found on ropes which are heavily loaded and operated at high speeds, but may develop on any rope that is subjected to severe abrasion on drum and sheaves. The lack of the proper tolerance in the sheave grooves also promotes conditions favorable for the formation of Martensite structure.

The proper handling of wire rope before and during installation is very important. When wire rope is transported from one location to another, care must be taken to avoid scuffing of the rope against foreign objects. Rope on reels should be properly blocked in place. Other objects should also be blocked so they cannot shift and accidentally come in contact with the rope.

When reels are unloaded from a vehicle, extra care should be taken in lowering the reel to the ground. Reels are not designed to be dropped with many tons of wire rope on them. In many cases, the center drum will collapse. It is extremely difficult to remove rope from a reel with a collapsed drum.

When installing a wire rope through multiple reeved blocks, extra caution should be exercised to keep the rope from jumping a sheave or chafing against the sheave guard. It is at this time that many ropes are kinked or "dog-legged."

Figure 4 shows a line that was operated over sheaves after it had been kinked. Wire ropes should never be pulled under sills or substructure during installation.

If these suggestions for the proper care of wire are followed, many extra hours of improved service will be realized.

Two of the most important prerequisites for good wire line service is proper application and a good service record. Consult your wire rope salesman for suggestions and information. —**The End**

FIGURE 4—Results of using a kinked line over sheaves. Careful installation and proper use might have avoided this breakage.

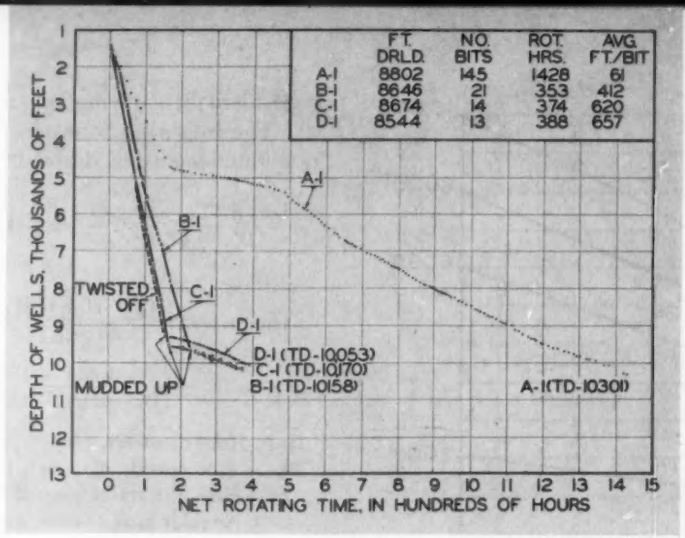


FIGURE 45

Keys to Successful Competitive Drilling

Part 6B

A series on modern drilling technology . . . Air and Gas Drilling.

By Roy A. Bobo, George S. Boudreaux and R. R. Angel, Drilling Engineering Division
Phillips Petroleum Company, Houston

Results. Before delving into the technique and requirements for drilling with air or gas, some of the results will be presented to indicate the savings that are possible over conventional drilling with mud. Figure No. 45 shows a comparison of one mud and three air-drilled wells in the Vinegarone Field of Val Verde County, Texas.[1]

The Cauthorn A-1 was drilled with mud, and the B-1, C-1, and D-1 with air. Over 1000 rotating hours and 120 bits were saved per well by drilling with air in preference to mud. This does not include the time saved on trips. It is interesting to note the change in drilling rate on the graph where the B-1, C-1, and D-1 were mudded up. Since there was no change in formation, the graph vividly presents a comparison of air and mud drilling. Before mudding up the hole, penetration rates up to 90′/hour were achieved with air. This compares with rates of 3 to 5 feet per hour subsequently obtained with mud. Bit footages varied from 1000 feet to 1500 feet per bit for air as compared to 40 feet to 100 feet for mud.

The following comparison illustrates results which were obtained in drilling with air on a well in the Puckett Ellenberger field of Pecos County, Texas:

Depth Interval	Type of Drlg. Fluid	Time-Rotating plus trip hrs.	No of Bits
5000-9762	Clear water	825	53
5000-9762	Air	285	10

Spectacular results have been obtained in other areas of the United States with air or gas drilling. For example, the following comparison of mud and air drilling has been presented for the Benzette Gas Field, Elk County, Pennsylvania:

	Mud	Air
Footage drilled	5497′	5846′
No. of 8¾″ bits	31	3 (2 tungstens)
Feet per bit	171.5	1907
Hours on bottom	320	172
Feet per hour penetration	17.5	33.2

Although many more examples could be quoted to show the large savings that can be made from air or gas drilling, many problems must be overcome before air or gas drilling can spread to other areas and take its place as a well developed science or drilling technique.

Volume and Pressure Requirements for Air and Gas Drilling. Circulation rates for air and gas drilling are usually selected to produce annular velocities that are

Chapter 6 is the concluding chapter of this series of articles on "Keys to Successful Competitive Drilling." This work will be bound in book form and some of the more important charts will be enlarged for practical field usage. These books can be obtained by writing: Book Department, The Gulf Publishing Company, Post Office Box 2608, Houston, Texas.

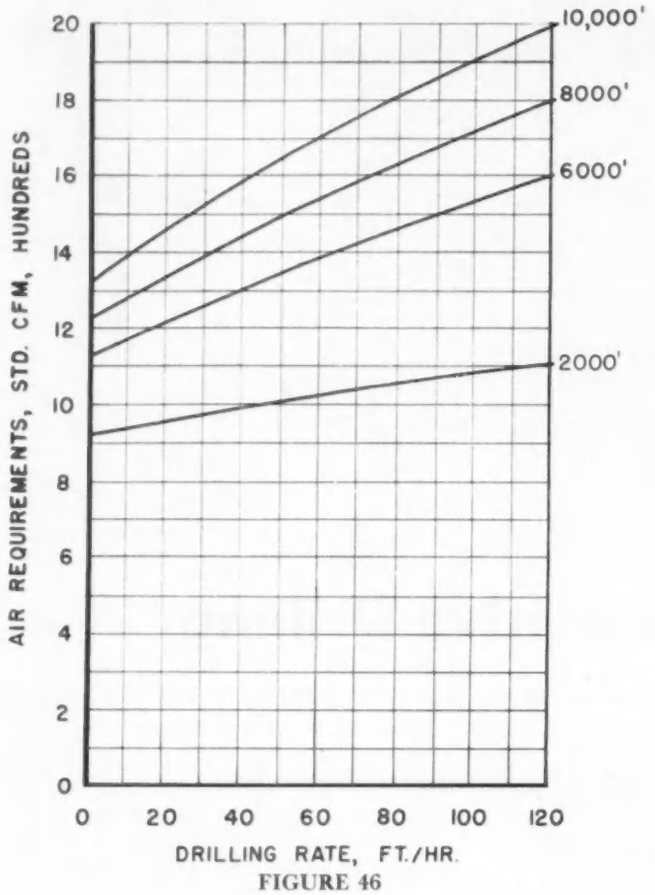


FIGURE 46

equivalent in carrying power to some standard air velocity. The following equation for determining these circulation rates has been derived.[2]

$$\frac{6.61\,S\,(T_s + Gh)\,Q^2}{(D^2_h - D^2_p)^2\,V^2_e} = \sqrt{[P^2_s + b\,T_{av}{}^2]\,e^{2ah/Tav} - b\,T_{av}{}^2}$$

.....Equation 1

Where: $a = \dfrac{S\,Q + 28.8\,K\,D^2_h}{53.3\,Q}$

$$b = \frac{1.625 \times 10^{-6}\,Q^2}{(D_h - D_p)^{1.333}\,(D^2_h - D^2_p)^2}$$

D_h = Hole diameter, feet
D_p = Pipe outside diameter, feet
e = Base of natural logarithms —2.71828
G = Annular temperature gradient, °R/Ft.
h = Depth, feet
H = Depth, thousands of feet
K = Drilling rate, feet per hour
N = Slope of curve denoting circulation rate vs depth CFM/1000 ft.
P_s = Pressure in the annulus at the surface, 16/ft² Abs.
Q = Circulation rate, standard ft³/min.
Q_o = Circulation rate for zero depth, standard ft³/min.
S = Specific gravity of the gas related to air.
T_s = Temperature in the annulus at the surface, °R
T_{av} = Average down hole temperature, °R
V_e = Velocity of standard density air, ft/min.

This equation was derived by incorporating the effect of the drilled solids in a vertical flow equation. A trial and error process is required to solve for the required circulation rate, Q. To facilitate computation, a simple

TABLE 6—Data for Calculating Approximate Circulation Rates Required to Produce a Minimum Annular Velocity Which Is Equivalent in Lifting Power to a Standard Air Velocity of 3000 Feet Per Minute.

Hole Size, Inches	Pipe O.D., Inches	AIR					GAS, SPECIFIC GRAVITY .60				
			VALUE OF N					VALUE OF N			
			Drilling Rate Feet/Hour					Drilling Rate Feet/Hour			
		Q_o Std. CFM	0	30	60	90	Q_o Std. CFM	0	30	60	90
17½	6⅝	4209	82.2	131	177	221	5434	66.3	128	186	240
	5½	4428	79.8	126	171	213	5716	61.8	119	174	226
	4½	4588	78.0	123	166	207	5924	58.0	113	165	215
15	6⅝	2905	71.7	112	151	188	3751	64.2	118	167	214
	5½	3124	68.7	107	143	178	4033	58.6	108	154	197
	4½	3285	66.0	103	137	171	4241	54.0	100	144	185
12¼	6⅝	1700	62.3	97.8	130	160	2194	63.0	112	155	194
	5½	1918	58.0	89.5	119	146	2477	56.3	97.7	137	172
	4½	2079	55.3	83.6	111	136	2684	50.8	88.2	124	157
11	6⅝	1237	60.6	94.5	124	151	1597	64.5	112	152	188
	5½	1456	54.8	83.8	110	135	1880	55.5	95.4	131	163
	4½	1616	50.6	76.9	101	124	2087	50.0	84.4	116	146
9⅞	5½	1079	53.0	80.3	104	126	1393	56.4	94.7	128	157
	5	1163	50.3	75.5	98.7	120	1502	52.3	87.7	119	147
	4½	1240	47.8	71.7	93.3	114	1600	48.8	81.6	111	138
9	5	898	49.1	73.0	94.4	113	1160	53.0	87.1	116	141
	4½	975	46.1	68.5	88.5	107	1258	49.0	80.3	108	132
	3½	1103	41.5	61.0	79.0	95.5	1424	42.0	68.9	93.1	115
8¾	5	827	49.0	72.7	93.2	112	1068	53.5	87.0	115	140
	4½	903	46.0	67.8	87.3	105	1166	49.1	80.0	107	130
	3½	1032	40.8	60.0	77.3	93.7	1332	41.8	68.3	92	114
7⅞	4½	670	44.7	65.0	82.7	98.3	865	50.1	78.8	104	125
	3½	798	39.2	56.7	72.5	86.9	1031	41.6	66.3	87.8	107
7⅞	3½	676	38.5	55.0	69.8	83.2	873	41.6	65.3	85.5	104
6¾	3½	535	37.3	52.8	66.1	78.0	690	41.5	63.8	82.3	99.0
6¼	3½	430	37.0	51.5	63.6	74.7	555	42.0	63.1	80.0	94.7
	2⅞	494	32.8	46.0	57.3	67.7	638	37.0	55.1	71.4	85.4
4¾	2⅞	229	31.6	41.3	49.5	56.5	296	37.0	51.3	62.6	72.2
	2⅜	271	27.8	37.2	44.8	51.6	350	32.3	45.6	56.3	65.5

Q (Required CFM) = Q_o + N x H (Depth in thousand feet)
Example: Calculate the circulation rate required to air drill 11" hole with 5½ drill pipe at the rate of 90 feet per hour at 11,000 feet.
Q = Q_o + N x H = 1456 + 135 x 11 = 2941 CFM

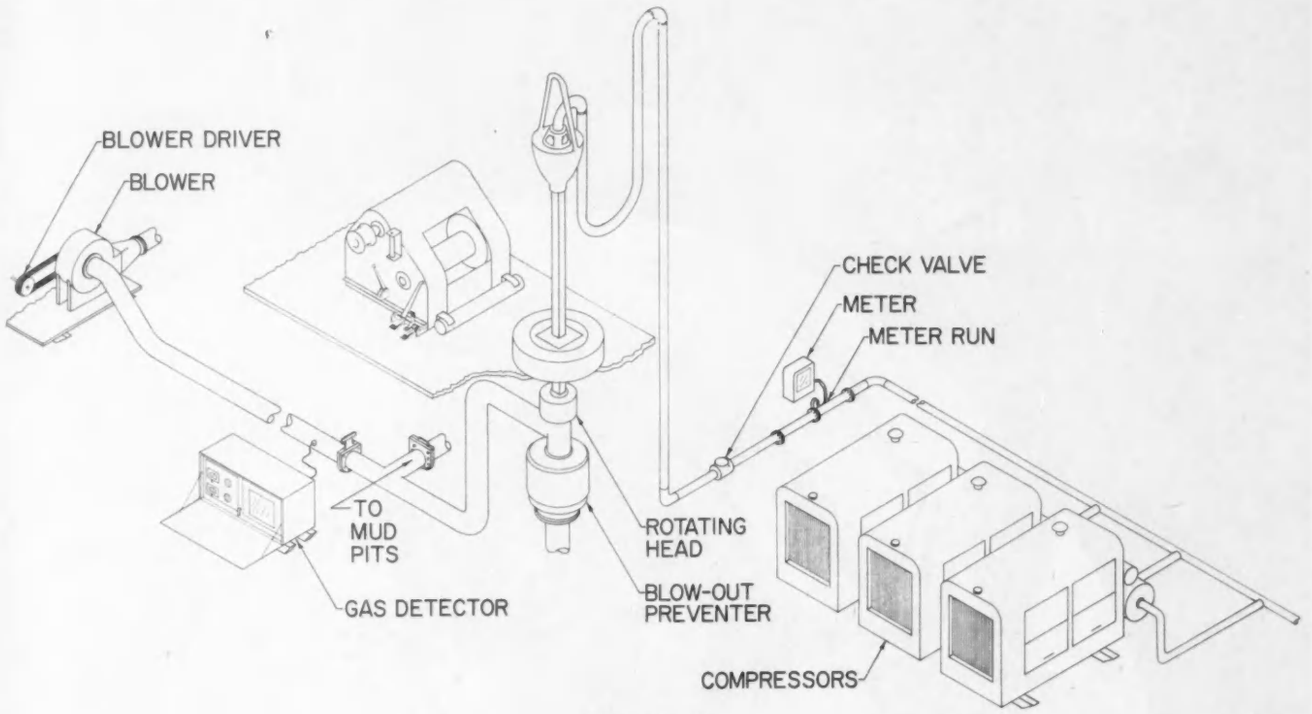


FIGURE 47

method of obtaining an approximate solution[2] is presented in Table No. 1. This approximate method is based on an equivalent annular velocity of 3000 feet per minute, which has proven satisfactory for drilling dry formations. The use of this table is recommended for determining basic circulation requirements. Of course, adjustments may be required to cope with problems that are peculiar to certain areas.

Figure 46 shows graphically how air volume requirements are dependent both on depth and rate of penetration.

In the common hole sizes, standpipe pressures usually range from 80 to 200 psig. Each side of Equation 1 is a solution for the bottom-hole pressure in 16/ft.[2] absolute. By solving for this pressure and using the proper data for calculating the pressure drop across bits and in the drill pipe, the theoretical standpipe pressure may be calculated. In actual practice the compressor output rating is generally dictated by other considerations such as the ability to unload the hole or handle water that may be encountered. Pressure ratings of the compressors that are commonly used range from 100 to 300 psi.

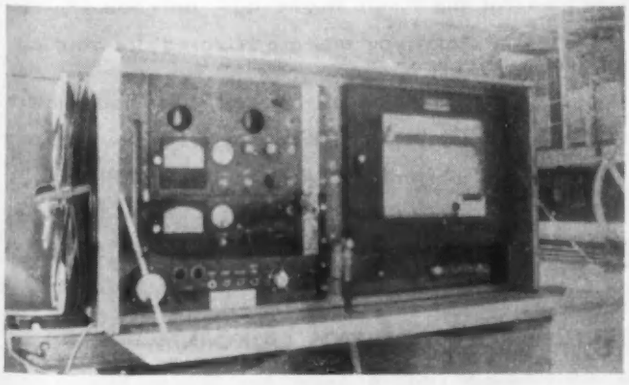


FIGURE 48

Equipment—Air and Gas Drilling. For all practical purposes, the arrangement of the rig equipment is the same as for conventional mud drilling with the air or gas supply line being tied directly to the standpipe. A typical schematic diagram of an air drilling hook-up is shown in Figure 47. Note that features which are additional to conventional drilling are the compressors, rotating head, flowline, gas detector, and centrifugal blower.

This equipment includes two innovations to air drilling rigs—the gas detector, and the centrifugal fan. Both are deemed important safety contributions to air drilling.

Gas Detector. A commercial gas detector, Figure 48, may be installed off a tap in the flowline to detect whether gas is being produced from the well and to determine the relative amount. It may be connected to sound an alarm when excessive quantities are encountered.

The gas detector also may be used with the rig's depth-drilling rate indicator to serve as an exploratory device.

Centrifugal Blower. One of the prime hazards when drilling with air or gas is the apparently inevitable leak around the rotating and well head assemblies. This danger can be entirely eliminated by holding a vacuum on the discharge line and well head.

A fan assembly having a 33-inch blast wheel driven at 1100 rpm handled the solids from 10,000 feet of air drilled hole in two Phillips' wells. This unit is shown in Figure 49. Although the useful life of the fan was terminated when the case became eroded, the cost for its use was considered quite low.

Effective use of a blower will necessitate a fairly large flow line in order to minimize loss of head. Since it is necessary to design the discharge system to handle some formation gas, a conveying velocity of 5000 fpm is suggested for systems designed to handle about twice the normal quantity of drilling air or gas. If cuttings settle out in the discharge line when no formation gas is being drilled, a

Your rig is only as good as its bite . . .

Globe S53C Rock Bit

. . . and the bite is only as good as the bit!

Here at Globe, where rock bits are designed, and engineered with the close cooperation of the "men in the rig", only the PROVED task-type bits are released for your use.

Through longer, more efficient performance of Globe Rock Bits, operators are realizing substantial savings in overall drilling costs.

GLOBE
OIL WELL DRILLING TOOLS

GLOBE OIL TOOLS CO.

Main Office and Plant: LOS NIETOS, CALIFORNIA

Branches In All Principal Drilling Areas Are Serving The Petroleum Industry With Field Engineered Drilling Equipment

Globe S3C Rock Bit

It's Clear as Crystal

With rising costs nibbling at your profits, it is important that you get every ounce of efficiency from your rig. Globe Rock Bits are equal to their part in this task by taking a full bite of formation with every turn of the drill string . . . working longer and at lower cost per foot of hole.

We invite you to compare the drilling qualities of Globe "Task-Type" Rock Bits and to benefit by the stepped up performance of your rig.

GLOBE
OIL WELL
DRILLING TOOLS

GLOBE OIL TOOLS CO.

Main Office and Plant: LOS NIETOS, CALIFORNIA

Branches In All Principal Drilling Areas Are Serving The Petroleum Industry With Field Engineered Drilling Equipment.

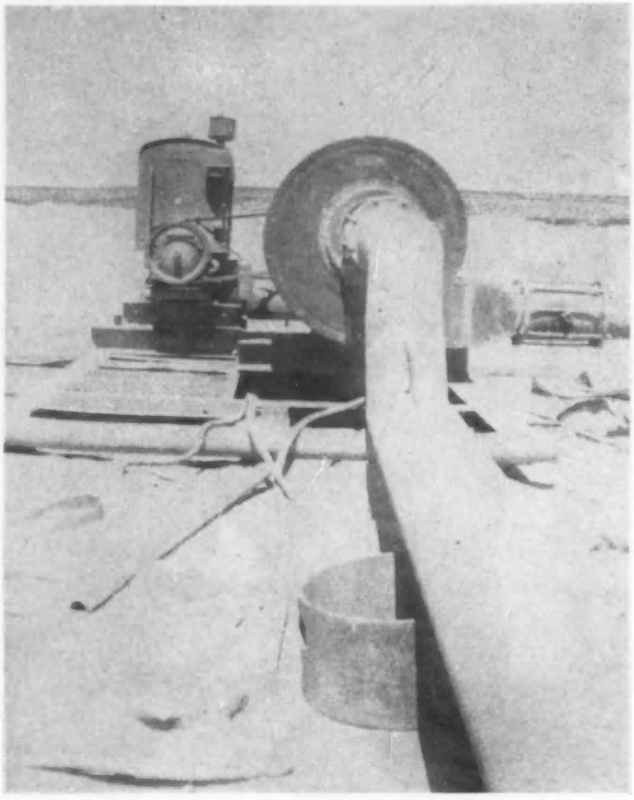


FIGURE 49

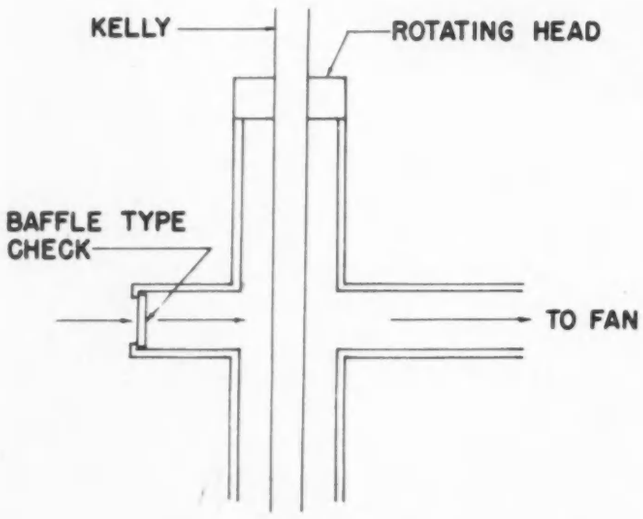


FIGURE 50

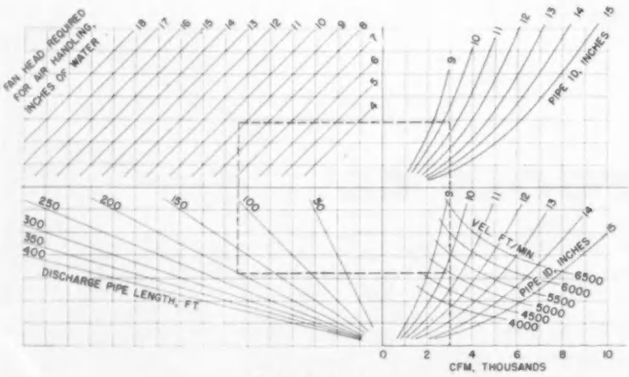


FIGURE 51

well head arrangement such as Figure 50 can be used to admit air at atmospheric pressure, and thus maintain an adequate conveying velocity in the discharge line. A provision to bypass the fan if water is encountered is desirable.

In order to eliminate any hazard when handling an explosive mixture an electrician should check the electrical ground existing between the fan housing and the discharge line, motor drive and exhaust line from the fan. A check should also be made for grounding of the fan rotor and a discharge brush provided if required. Static conducting belts should be used if a belt drive is employed. A hydraulic drive will allow location of the prime mover away from the fan and should be used for maximum safety if the prime mover is a source for ignition.

The nomograph in Figure 51 has been prepared to determine the required pipe size for different conveying velocities and to ascertain the total fan head required for air handling. This total fan head includes the friction drop in the line, the entrance loss, and the velocity head based on a fan system which is drawing atmospheric air from an open ended suction line. Technically, the design procedure would require a density correction for natural gas but this correction can usually be omitted without serious error. A correction factor for solids loading can be obtained from the nomograph presented in Figure 52. The design steps are summarized as follows:

(1) Select a design air rate. This is the normal drilling air or gas plus the formation gas that can be expected. It is suggested that the design air rate should be at least double the normal air or gas circulation rate.

(2) From the nomograph in Figure 8, select a line size that will give a linear velocity of 5000 feet per minute at the design rate. Also determine from the nomograph the fan head required for handling air at the design rate.

(3) From Figure 9, find a solids correction factor based on the design air rate, the expected maximum drilling rate and the hole size.

(4) Multiply the fan head obtained in step 2 by the correction factor obtained in Step 3 to obtain the corrected total fan head for air laden with drilled solids.

(5) From fan characteristic curves such as Figure 53, determine the required rpm and fan drive horsepower.

(6) Select a prime mover to supply 1.5 times the indicated horsepower to the fan drive. A hydraulic drive powered by an internal combustion engine is recommended.

Example 1
Normal Drilling Air—1500 CFM
Design Air Rate—3000 CFM
Length of Discharge Line—200 feet
Maximum Expected Drilling Rate—60 ft./hr.
Hole Size—8 inches
From Figure 6
Line Size for 5000 FPM—10½-inch ID
Fan Head Required for Air Handling—9.5 inches of water
From Figure 7
Solids Correction Factor—1.27
Corrected Total Fan Head—1.27 × 9.5 = 12 inches of water
From Figure 8
Use 1565 RPM for 12-inch Head and 3000 CFM
Drive Horsepower—10
Use 1.5 × 10 = 15 Drive Horsepower
For Hydraulic Drive (80 percent over-all efficiency)
Engine horsepower rating for continuous service, 15/.8 = 19 hp

Technique. The technique of air or gas drilling is similar to mud drilling with the exception that one circulating fluid is a compressible medium and the other is not. As

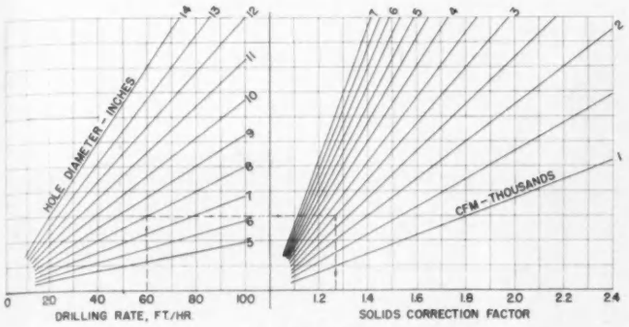


FIGURE 52

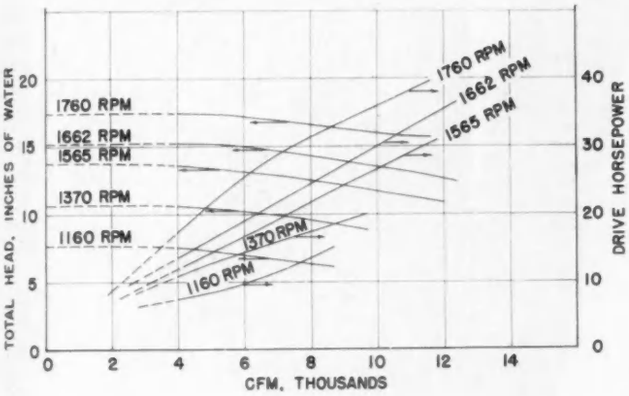


FIGURE 53

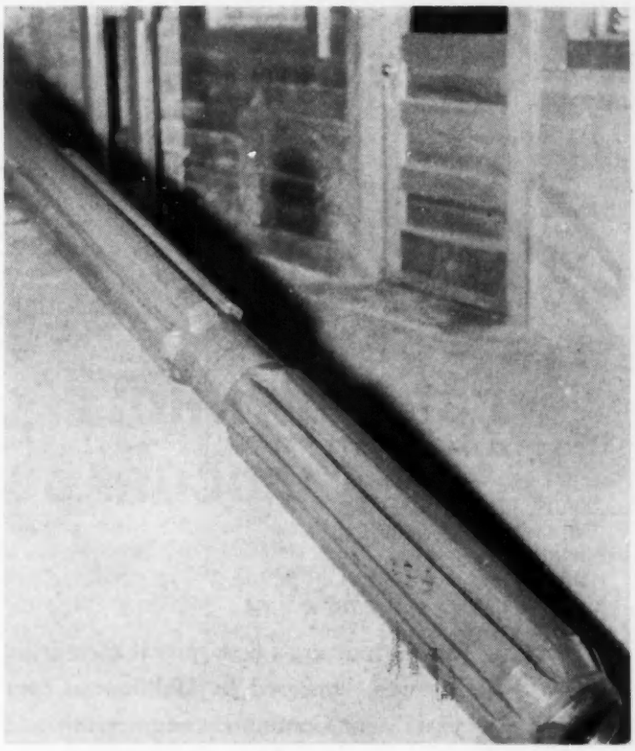


FIGURE 54

has been shown, penetration rates are much faster when drilling with air or gas. In many cases, bit weights are much lower, either because they are not necessary for exceptional penetration rates, or because hole deviation becomes a problem at the high drilling rates.

Problems—Air Drilling. Up to this point, only the favorable results have been shown in drilling with air or gas. But what about the problems?

In areas where formations are dry, no serious problems exist with the possible exception of hole deviation and pipe stresses. Unfortunately, not too many areas have long sections of hole that are completely dry. Water intrusion is the greatest single deterring factor to air or gas drilling.

Water: Water intrusion can be broken down into two types—weeping water zones and prolific water zones. The weeping formations can usually be penetrated if enough care is taken. However, they do slow up penetration rates and present the danger of sticking the pipe in the hole due to the cuttings balling up from the moisture and sticking to the drill string. Several methods are being used to penetrate these weeping zones successfully. Additional water added periodically at the surface has helped to overcome the stickiness and allowed drilling ahead. Aeration drilling by Phillips Petroleum Company demonstrated that foaming would reduce the surging that results from lifting of fluids from the annulus, and give improved lift efficiency. Murray[3] reports on adding foaming agents to the air stream to help in lifting water from the bore hole.

However, the greatest problem in air drilling is the prolific water zones that give up large quantities of water. These zones must be sealed off for three reasons:

(1) The influx of water increases the hydrostatic pressure on the rock thereby slowing penetration rates;

(2) Disposal of the water on the surface is too great a problem to overcome when producing large quantities of water;

(3) The air and water may create a corrosion problem as will be pointed out in the aerated mud section.

To successfully air drill, these zones have to be sealed off against high pressure differentials. For example, at 10,000 feet with a normal pressure gradient of water, it can be anticipated that approximately 4000 psi will be the formation pressure tending to flow water into the hole. Practically no hydrostatic pressure exists when drilling with air; therefore any sealing material will have to withstand 4000 psi of pressure differential. For this reason, the sealing material must penetrate the formation to form a strong bond that will withstand these high pressures. It is known that water may be present in large quantities in such zones as sands, fractured limestones, vugular limestones, and dolomites. Since solids will plaster off on the face of a sand and not penetrate, the problem is resolved into finding a liquid with a very low viscosity that will penetrate the formation and then polymerize or gel.

Several materials have been found that show a great deal of promise but have yet to be proved convincingly in field practice. The successful sealing of water zones will open more areas to air or gas drilling and will pave the way to greater savings for the oil industry.

Water Location: Many wells have been drilled with mud in areas that need to be investigated for possible air drilling. The electric logs can only indicate where water might be present and whether it could be of sufficient quantity to hinder air or gas drilling. Naturally in the past, operators have been looking for oil and/or gas and no one has paid too much attention to locating water. Two questions should be answered: (1) Are the formations dry for air or gas drilling?

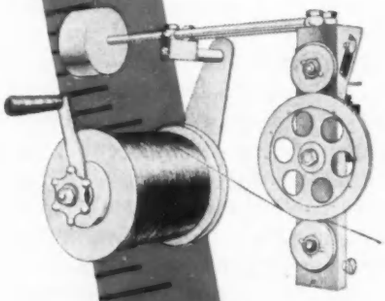
Yardstick

FOR DOWNHOLE ACCURACY

The oil industry's first special measuring device was pioneered by Halliburton over 30 years ago. Continuous engineering and development since has enabled Halliburton to maintain leadership in this field... and Halliburton's present-day equipment is unmatched for accuracy, efficiency and variety of selection.

Halliburton's Standard, Heavy Duty and Extra Heavy Duty Type Measuring Assemblies can be operated by hand, or driven by gasoline or diesel power, rear wheel of autos, or cathead operation. The unusually accurate Veeder Counter practically eliminates guesswork and miscalculation because it reads exact depths in either feet or meters.

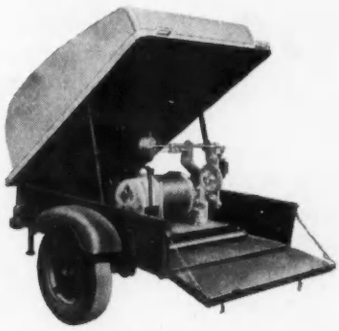
Whatever your measuring requirements, Halliburton has the right device or combination of equipment to meet them. A Halliburton representative will be glad to help you analyze your needs.



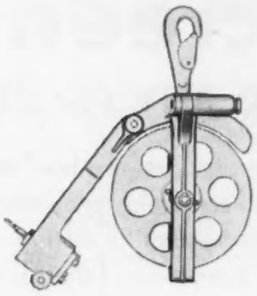
HALLIBURTON OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

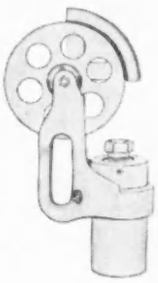
MEASURING LINES... various lengths up to 25,000 feet, available in diameters of .066", .072", and .092". Three different types; 1. Regular-black, non-coated steel; 2. Galvanized-coated steel, impregnated; 3. Stainless-steel for wells containing hydrogen sulphide.



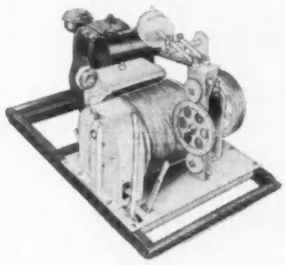
TWO-WHEEL TRAILER... with ample space for even the largest Halliburton Power Driven Measuring Assembly. Specially designed for portability over rugged terrain. All-steel construction. Overall length of 105". Recommended carrying capacity of 1,500 lbs. Metal cover is optional.



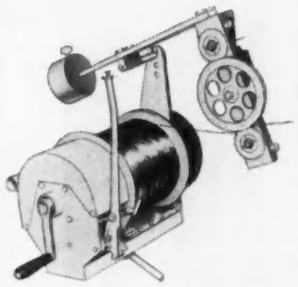
LATCH TYPE HAY PULLEY AND LINE WIPER... required for running measuring line in open holes, drill pipe, tubing or casing. Safety plus speed are provided by iron latch type guard and frame. Measuring Line Wiper is optional, cleans line as it is retrieved.



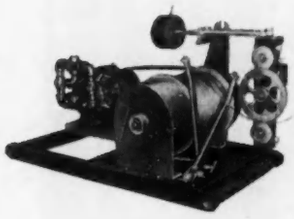
STUFFING BOX AND STAFF ASSEMBLY... specially designed for measuring operations in open hole or casing while well is shut in under pressure up to 15,000 psi. Safer operating due to aluminum line guard and frame. Variety of models for different diameter Measuring Lines.



POWER-DRIVEN MEASURING ASSEMBLY (Extra Heavy Duty Type—Standard)... is capable of safe, efficient measuring in even the deepest wells. All controls, clutch, and brake levers grouped for easy operation. Driven by a 1-cylinder, air-cooled gasoline engine with gear reduction Power Take-off. Also available with 9.2 h.p. gas engine with twin disc clutch Reel.



HEAVY DUTY MEASURING DEVICE... for measuring requirements, surveys, etc., where well depths are greater than line capacity of reel with Standard Measuring Device. Can be mounted to Jack Post on Rotary Rig for manual or "cathead" operation.



AIR POWERED MEASURING ASSEMBLY... driven by compressed air power for extra safety and flexibility. Especially suited for well measurements where there is a need for high starting torque, accurately controlled variable speed, or where a possible fire or safety hazard exists. Air motor used is a radial 5 cylinder unit with built-in gear reduction.

HALLIBURTON MEASURING EQUIPMENT

284 SERVICE CENTERS • JUST MINUTES AWAY FROM YOUR WELL

For more data on advertised products, use Readers' Service Cards, last page.

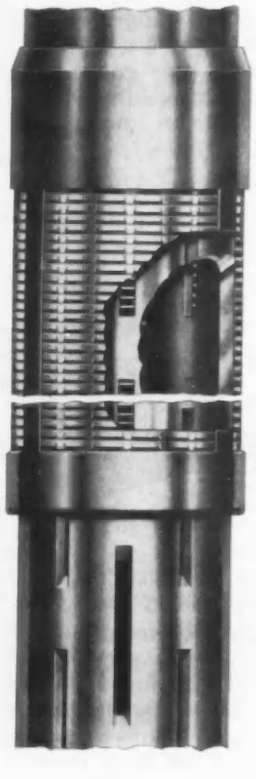
Screen Pipe

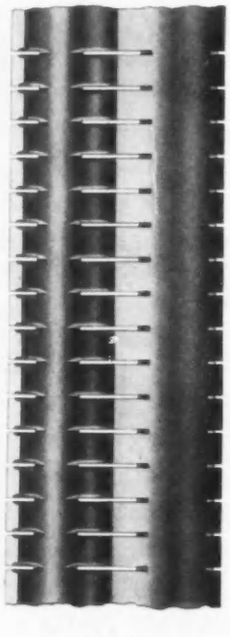
FOR ANY REQUIREMENT . . .

Emsco products are backed by long experience in well screening problems. Years of successful use and scientific testing in U. S. and foreign fields have proved their superiority.

Emsco Wire Wrapped Screen with Vertical Slots provides 50% to 60% more opening per foot than conventional drilled holes. It retains 25% more tensile strength than drilled pipe.

WIRE WRAPPED





SLOTTED

Emsco Slotted Screen Pipe retains 80% to 85% of the original collapsing strength of the pipe. It may be rotated or spudded reasonably without risk of damage. Its smooth surface facilitates setting and pulling . . . prolongs its life. Slots are milled from the inside and sawed from the outside, "V" shaped for maximum drainage and minimum clogging, ⅛" straight wall connects outside opening to beginning of "V" on inside. Slots are so arranged that strips of solid steel run full length of pipe. A few feet of screen provides drainage area equal to full capacity of the pipe.

EMSCO SCREEN PIPE CO.

3 Ricks Road **Houston 21, Texas**

Export Office: VAL R. WITTICH, INC.

30 Rockefeller Plaza New York 20, N. Y.

(2) If not how many formations will have to be sealed off during air or gas drilling?

Pipe Stress: With any method of rock bit drilling, several torsional and vibratory or shock stresses are transmitted to the pipe. These stresses tend to be damped out to some extent by mud in the hole. With air, no dampening occurs and no mud is in the hole for buoyancy of the pipe during trips. For these reasons, the drill string during air drilling remains in a higher state of stress than with mud. The additional damage to the drill pipe will be determined only after more experience is acquired at greater depths with air drilling.

Hole Deviation. In the initial field trials of air and gas drilling, hole deviation was a serious problem which necessitated carrying much lower bit weights than desired. Holes deviated as much as 40° off vertical.

Most holes drilled with air or gas are usually in gage adding to the effectiveness of stabilization. Hole deviation was maintained close to vertical in the wells drilled in the Vinegarone field, Val Verde County, Texas, by use of a steel-rib type stabilizer immediately above the bit and a conventional rubber stabilizer approximately 60 feet above that. The steel ribbed stabilizer is an old tool, which has been little used in recent years. Results were better than anticipated since the Vinegarone field is in an exceptionally bad crooked hole area.

Figure 54 shows the tool which consists of a 20-foot, 7-inch OD drill collar with ribs welded to its outside to bring the collar diameter to ⅛ inch smaller than the bit being used. These ribs are installed, starting immediately above the box in two 8½ inch segments, with the ribs indexed or staggered so that those of the upper segments are aligned with the circulation grooves in the lower segments.

Future of Air and Gas Drilling. The future of air and gas drilling is assured. The savings in time and money are almost unbelievable and have been proved in certain areas of West Texas, New Mexico, Arkansas, Oklahoma, Rocky Mountains, and Canada. The successful solutions to locating water and sealing off water zones will open up many more areas to drilling with air or gas and will lead to greater savings for all who take full advantage of this new method of drilling.

SUMMARY

The authors have shown the current status of reduced pressure drilling. The judicious use of this new method of drilling as it is now practiced can guarantee large savings to the operator and drilling contractor. Cooperation and exchange of information by all concerned can improve the method even further, overcome the problems, and insure larger savings in the future.

ACKNOWLEDGMENT

The authors wish to express their appreciation to Phillips Petroleum Company for granting permission to present this series of articles.

REFERENCES

[1] "Air Drilling in Val Verde Basin," R. W. Horton, WORLD OIL, June, 1957, Pages 130-133.

[2] "Volume Requirements for Air or Gas Drilling," R. R. Angel, presented at fall meeting of the Petroleum Branch of A.I.M.E., Dallas. October 7-9, 1957.

[3] "Water Still Poses Tough Problem in Drilling with Air," A. S. Murray and S. P. McKay, *The Oil & Gas Journal*, June 10, 1957, Pages 105-112.

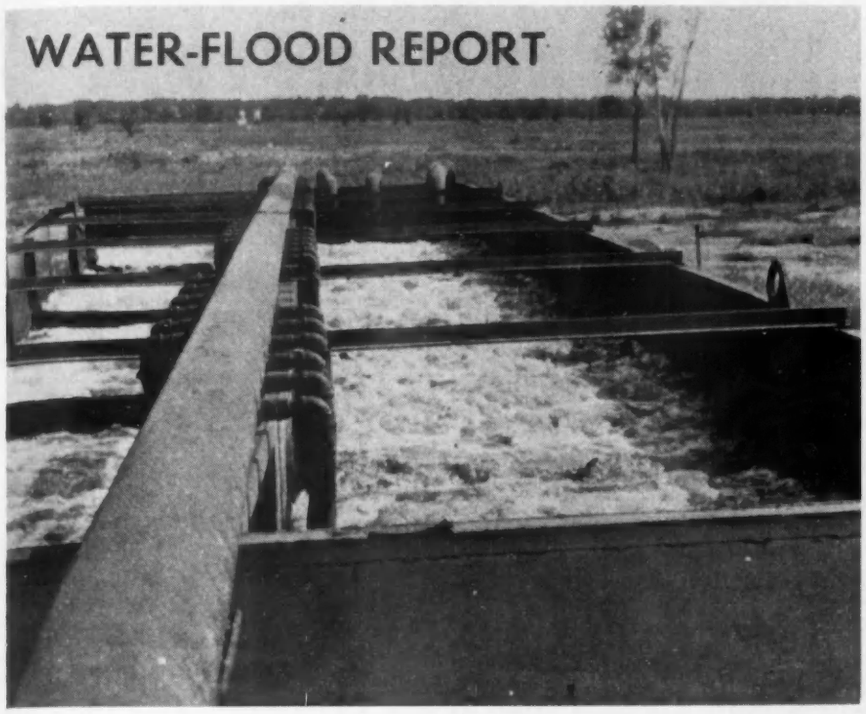


FIGURE 1—Top view of air-diffusion degasifier tank.

New Trends in Treating Waters for Injection

By J. Wade Watkins
U. S. Bureau of Mines, Bartlesville, Okla.

THE TREATING of brines for subsurface injection is becoming a technology in itself. Recent developments include increased emphasis on more complete separation of oil from the accompanying produced water, and the use of closed injection systems where possible.

New methods for removing dissolved acidic gases from waters include controlled aeration, "scrubbing" with combustion gases or natural gas in packed columns, use of submerged burners, and chlorination.

Organic treating chemicals are available and are finding extensive experimental application as biocides, corrosion inhibitors, and wetting agents. The use of sequestering agents has been increased; specific complexing additives are used to sequester or chelate some of the more troublesome metallic ions.

New and improved chemical feeders and sedimentation tanks and ponds have been designed. Changes in filtration procedures are seen in the development of corrosion-resistant element-type filters and the increased use of diatomaceous-earth filtration. Non-corrodible plastic and cement-asbestos materials and corrosion-resistant metallic alloys have been improved and are used more extensively for many purposes. Automatic controls have been utilized to a greater extent.

The use of water analyses in designing plants and controlling treating processes has received recent emphasis and much attention is being given to detecting, evaluating, and controlling micro-organisms in injection waters. Although good progress has been made toward solving many injection water treating problems, the available information pertinent to many other problems is scanty and incomplete. Additional research work is justifiable to attain optimum treating procedures.

Oil-Water Separation. The incomplete separation of oil from water has serious adverse effects on water-conditioning systems. The presence of even minute quantities of oil in raw water causes fouling of lines, treaters, and pond or tank walls. Even more troublesome is the removal of oil films by filter media, thereby necessitating recharging of filters or replacing elements. Oil in any quantity may be incompatible with some treating chemicals; for example, quaternary-ammonium compounds are soluble in crude oil.

Increasing use is being made of emulsion treaters for separation of free and emulsified water from oil.

Oil-skimming compartments frequently are used, either as separate ponds or as compartments in aeration or primary settling ponds. These are isolated by baffles, installed and adjusted to permit flow of water under the baffles and to retain oil floating on top of the water. Even two such stages often will not give complete separation. An expedient used by at least one operator has been to flow produced brine countercurrent to kerosine in a tower to remove traces of crude oil. Stormont[31] described the use of countercurrent flow of gas in a "flotation cell" for the same purpose.

Closed Systems. The economic advantages of closed treating systems, where permitted, have been discussed elsewhere.[4, 34] Many closed systems are being used to inject waters having low or negligible concentrations of dissolved hydrogen sulfide and iron, although such waters may contain comparatively high amounts of dissolved free carbon dioxide. In a few plants waters containing considerable dissolved hydrogen sulfide or ferrous iron are injected through closed systems. However, this procedure often is not practicable. Where the perme-

Visco CUTS EMULSION-BREAKER COSTS

. . . on large leases

. . . or small

Visco's emulsion-breaking economy goes clear across the board . . . big operations or small . . . tough- or easy-to-break emulsions. It makes no difference whether you need a drum of emulsion-breaker a day or one every six months—you can be certain your Visco Field Service Man will find the right formula to give you dry oil at lowest cost. For fast action, call Houston, JAckson 8-2495, Collect.

VISCO PRODUCTS COMPANY
INCORPORATED
1020 Holcombe Blvd., Houston 25, Texas

Visco® CONSISTENTLY EFFICIENT OIL FIELD CHEMICALS

ability of the injection formation is high enough that some precipitation of iron or carbonate compounds is not deleterious, gradual plugging of sand pores may be ignored until reductions in injection rates force the cleaning out of wells. Corrosion caused by dissolved hydrogen sulfide also may be written off, if not too serious, as normal depreciation of water-flood equipment, amortized over a period of years. The most critical consideration in a closed system is maintaining the system completely airtight. Corrosion and precipitation are increased if any air enters the system. There is a definite trend toward the use of closed systems for handling injection water.

Dissolved-Gas Removal. A large part of all corrosion in water plants and systems is caused by the common dissolved gases; oxygen, free carbon dioxide, and hydrogen sulfide.[37] If the dissolved gases are removed, corrosion should be materially lessened. Many methods have been used for removing dissolved gases, particularly the acidic gases usually found in subsurface waters.

The most common method has been aeration. One of the principal disadvantages of aeration is that the extent of aeration necessary to remove dissolved acidic gases is so great and the control of the degree of aeration so dependent upon the basic design of facilities and atmospheric conditions that such systems often are overdesigned. This results in undesirable solution of atmospheric oxygen in the water. Dissolved oxygen may be partly removed by vacuum deaeration in packed columns.

However, disadvantages of this practice are found. For instance, one additional step is introduced into the treating process. Vacuum deaeration is expensive, the mechanical removal of dissolved oxygen to a residual concentration less than 1 ppm is quite difficult; and the removal of dissolved oxygen usually is accompanied by the removal of some free carbon dioxide. Carbon dioxide removal changes the carbon-dioxide-bicarbonate-carbonate balance and promotes precipitation of metal carbonates in the column. For these reasons, vacuum deaeration has largely been discontinued in many plants.

One new method of dissolved gas removal is the use of either synthetic or natural combustion-exhaust gases

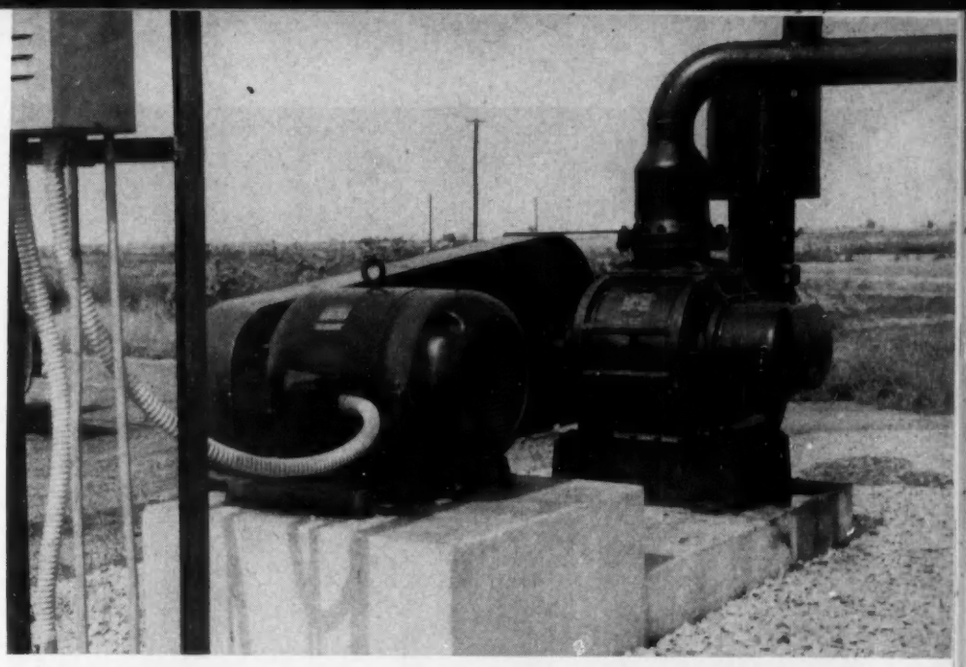


FIGURE 2—Blower used as air supply for air-diffusion gassifier.

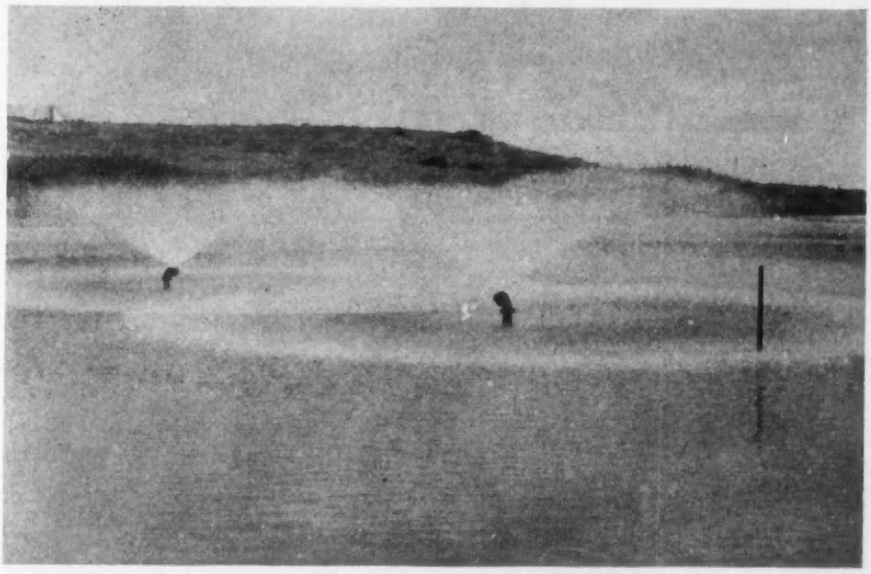


FIGURE 3—Spray aerators and aeration pond.

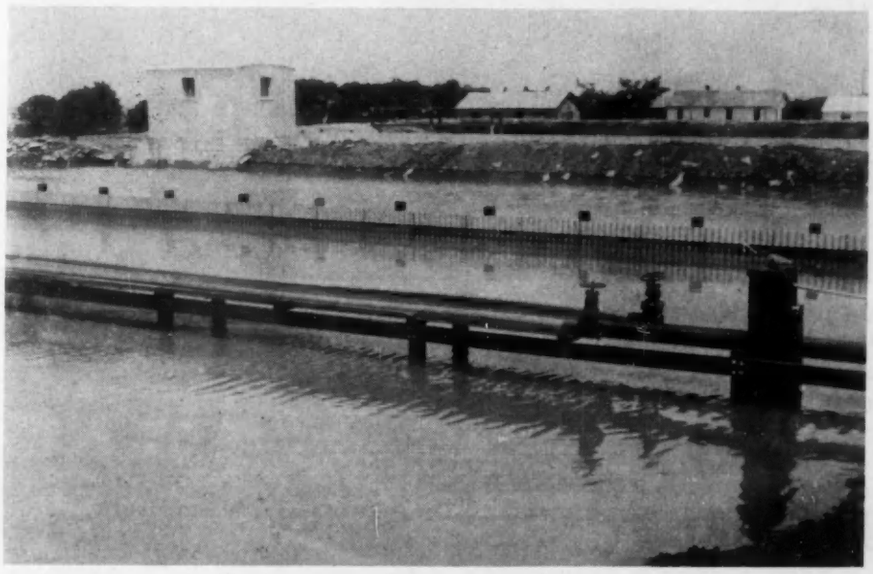


FIGURE 4—Plastic spray aerators and aeration pond.

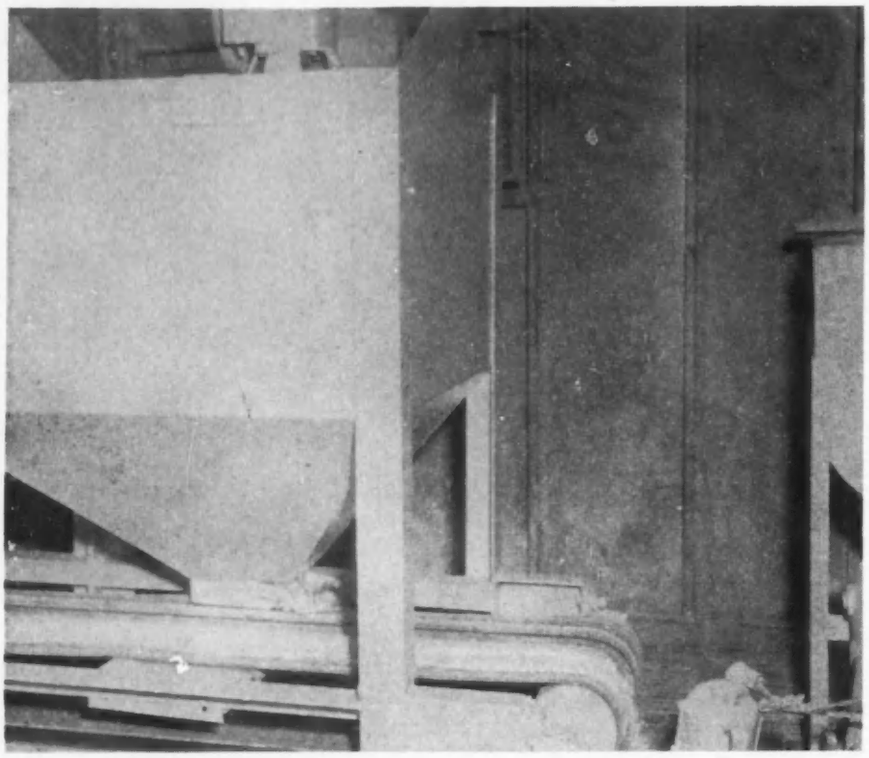


FIGURE 5—Dry chemical feeder with variable-speed conveyor belt.

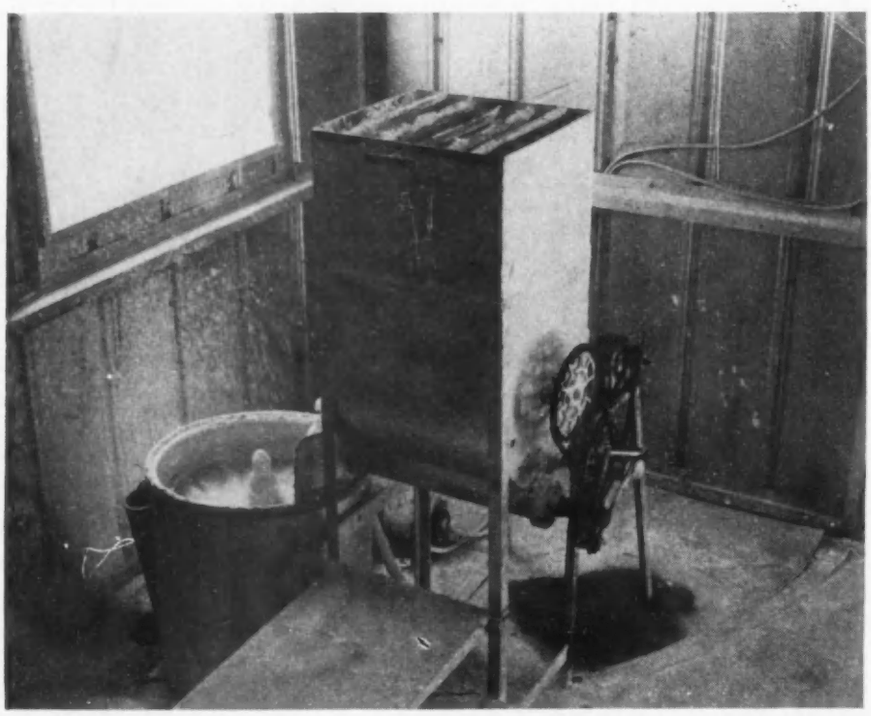


FIGURE 6—Washing machine used for mixing and solution of chemicals proportioned from dry feeder.

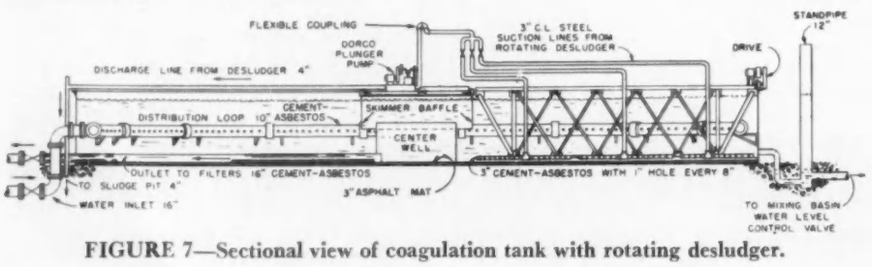


FIGURE 7—Sectional view of coagulation tank with rotating desludger.

to remove hydrogen sulfide and oxygen from water by countercurrent scrubbing in a packed tower. One application of this method has been described by Doscher and Tuttle;[19] the principles involved have been discussed elsewhere by Crawford.[18] Similar degasification operations have been conducted by using a submerged burner.[24] A method for the deaeration of water by scrubbing with natural gas has also been described in the literature.[15]

Changes in aeration procedures also are evident. Many forced-draft blowers now are used with tray-type aerators. One recent innovation has been the use of a submerged diffusion manifold for controlled aeration of brines, as illustrated in Figure 1.

The diffusion aerator or degasifier pictured here is housed in a rectangular steel tank 10 feet wide by 36 feet long by 6 feet deep, with a working capacity of about 425 barrels and a daily throughput capacity of 10,000 barrels. Air is discharged from the central manifold through x-shaped slits in 1-inch tubing loops under the surface. A mixture of about 25 percent of produced brine containing 30+ parts per million iron, and about 75 percent Arbuckle supply water containing 140+ parts per million dissolved hydrogen sulfide at pH 6.7 at the inlet is discharged from the unit with about 8 parts per million of dissolved iron and no dissolved hydrogen sulfide at pH 8.0. The concentration of free carbon dioxide also is proportionately reduced, from about 200 parts per million to less than 20 parts per million. Air is supplied from a 10 by 15-inch blower, pictured in Figure 2, powered by a 40-horsepower motor. The blower has a capacity of 1360 cfpm at 4 psig pressure.

The use of spray nozzles for water aeration is becoming more widespread. Frequently the nozzles are fabricated from plastics or other nonmetallic materials to prevent corrosion and minimize orifice plugging by precipitated solids.

Nozzles that spray water upward are pictured in Figure 3. Figure 4 is a photograph of a plastic aeration system in which the spray is directed downward into the pond to minimize the loss of water vapor. The electrical switch of a float-actuated control system is visible in the right foreground.

Chlorine is being used in more plants to oxidize traces of hydrogen

sulfide. However, chlorine is used as an oxidant only to supplement, rather than replace, aeration because of the high cost and great potential corrosivity of chlorine. Few efforts have been made to use reducing agents, such as sodium sulfite, in concentrated brines because of their tendencies to combine with metals through chemical exchange to form insoluble compounds.

Chemical Treatment. Lime is still the principal alkaline agent used for pH control because of its low cost, ready availability, and ease of handling. There has been a trend away from the use of aluminum sulfate as a coagulant toward the use of others, such as ferric sulfate and ferric chloride. Probably the most notable change in treating procedures in the last several years has been the increased use of organic treating compounds, such as biocides, corrosion inhibitors, and wetting agents.

1. Biocides. Although it has been known for many years that numerous kinds of organisms, including several strains of bacteria, were prevalent in both brines and fresh waters, there has been a growing awareness in recent years of the deleterious effects that may be caused by such organisms.[2, 38] Particular attention has been given to the presence and effects of sulfate-reducing bacteria.[3, 6] The increased interest of oil producers in microbiology has been the combined result of increased emphasis on technology in water-flooding, the availability of organic biocides, and the fact that operational difficulties caused by micro-organisms, either in the nature of plugging or corrosion, are by nature cumulative rather than immediate. Micro-organisms often contaminate an injection system to the point that stringent remedial measures are necessary. More attention is being given to early and periodic examinations to detect micro-organisms, to bacteristatic control, rather than attempting to achieve a complete kill, and to the standardization of microbiological test methods.[5]

Common biocides now in use include the quaternary-ammonium compounds,[8, 13, 26, 39] mercuric and phenolic compounds, fatty and rosin amines, and old standbys such as chlorine, formaldehyde, and copper sulfate. Most biocides have both advantages and disadvantages, influenced by the types or strains of organisms present, compatibility with other substances used for treating or naturally present as dissolved salts in the injection waters, and cost.

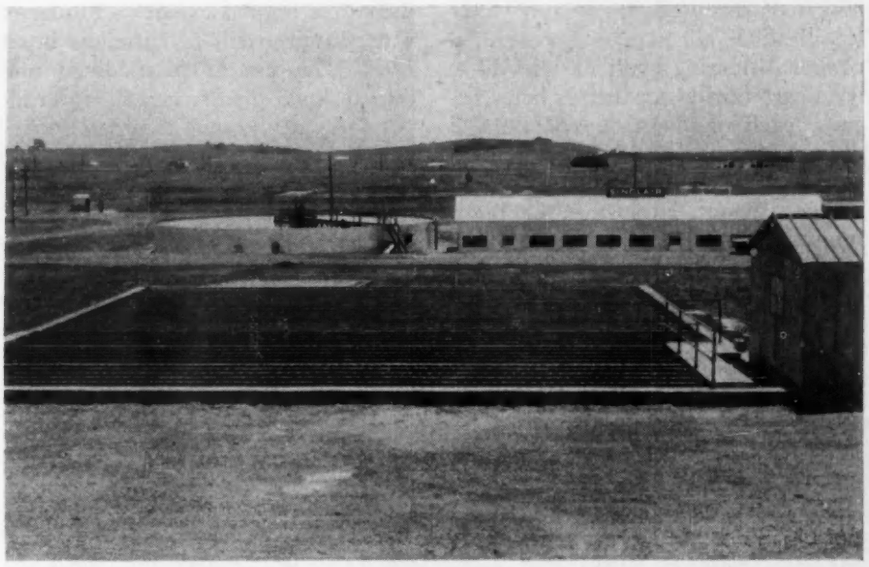


FIGURE 8—Mixing and flocculation basin, showing arrangement of "end around" baffles.

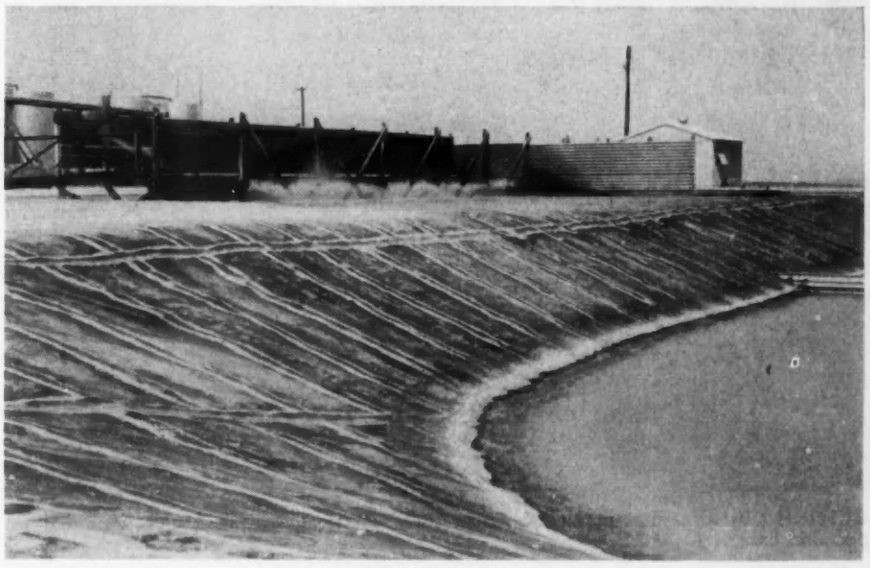


FIGURE 9—Corner of sedimentation pond, showing method in which asphaltic lining has been applied.

2. Corrosion Inhibitors. Whenever the common metallic alloys are in contact with water, some corrosion may be expected. This is especially true of ferrous alloys. The usual indeterminate factors are the severity of corrosion and the extent to which corrosion may be minimized. The adverse effects of severe corrosion are immediate, usually visible, and of economic concern, as opposed to the effects of micro-organisms, which may be concealed for longer periods. Secondary effects of corrosion, such as plugging of meter screens and porous rock formations by corrosion products, are less costly than leaks from corroded systems; although they are equally troublesome.

It is easier to recognize that corrosion-protective measures are necessary than to accept the fact that a serious micro-organic problem may exist.

Corrosion-prevention measures may be divided generally into the following categories, listed in order of the current trend of emphasis on their importance:

1. Chemical inhibition
2. Removal of dissolved-gas
3. Use of non-corrodible materials
4. Use of corrosion-resistant alloys
5. Stabilization of injection waters

Although chemical inhibition, re-

moval of dissolved gases, and water stabilization all may be considered chemical-treating methods, they have been arbitrarily separated here because each represents a separate and distinct step toward corrosion control.

The current interest in chemical inhibition is largely a result of the availability of organic treating compounds that possess both corrosion-inhibiting and biocidal properties. Field and laboratory tests made with organic inhibitors such as the quaternary, rosin, and fatty amine compounds, reportedly have indicated favorable results in minimizing corrosion caused by dissolved acidic gases.[13,26,28] Attempts to inhibit oxygen corrosion apparently have been less successful.

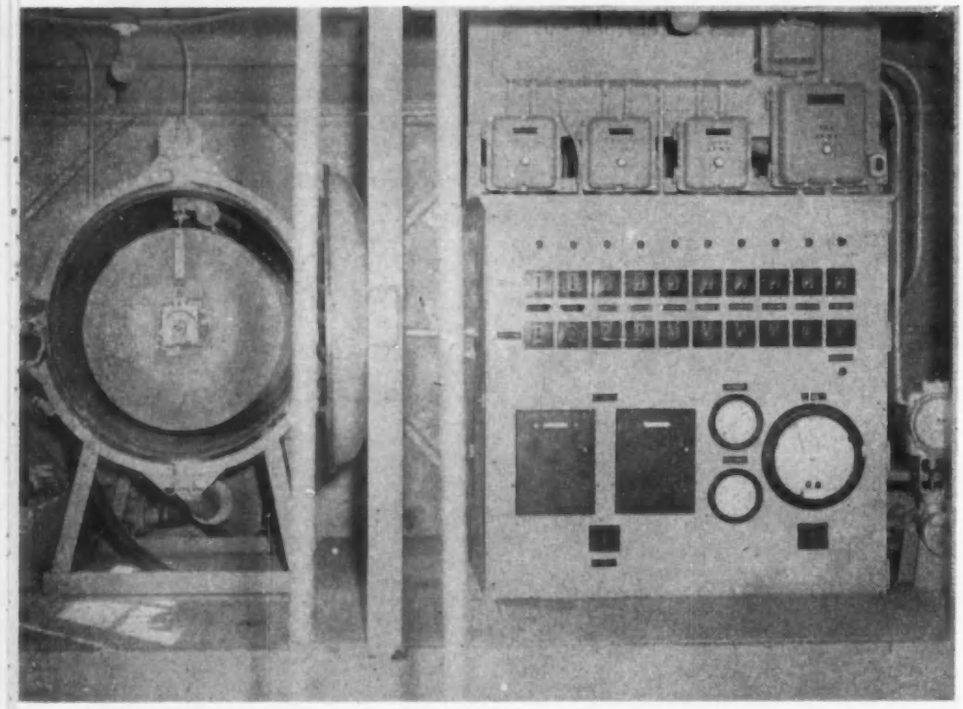


FIGURE 10—Diatomaceous earth filter and electrical control panel, mounted on portable base.

The new experimental methods of dissolved-gas removal discussed previously have been developed primarily to combat corrosion. Additional work, both in the laboratory and field, on improved methods of dissolved-gas removal, is desirable.

The availability of improved non-metallic materials, chiefly plastics, for fabricating tubular goods and other production equipment, has promoted wider use of non-corrodible materials. Cement-asbestos and plastic pipe now are used extensively in brine-gathering lines and low pressure water-distribution lines. Plastic pipe has been used to a limited extent as tubing in water-supply wells and shallow input wells. The use of plastic-lined and cement-lined pipe strings in water-input wells has become common. Porcelain plungers are commonly used to good advantage in positive-displacement injection pumps. Plastic (instead of steel) spray nozzles have been used in aerators; and plastic trays have been used successfully in aerating towers. The trend toward the use of plastic and other non-metallic equipment will likely continue.

Although some metallic alloys afford good corrosion resistance in certain environments, their use has not been widespread due to the higher cost of corrosion-resistant alloys compared with carbon steel. Too, alloys which are resistant to corrosion in an oxidizing environment often are corroded badly in a reducing one.

The practice of adjusting the pH and carbonate supersaturation of water to values that will promote precipitation of a carbonate film on metal surfaces, is not now used extensively with brines in injection systems. The reasons are that the protection afforded is neither good nor uniform, and any precipitation of solids in input wells is undesirable.

3. Sequestering and Chelating Agents. In most brine-injection systems a primary water supply from some source other than the oil-productive formation is required. It also is expedient in most instances to dispose of produced brines by injecting them into the oil-productive formation through wells in the flood pattern. Therefore, the chemical compatibilities of two or more waters from different sources becomes important. The significance of water incompatibilities has been discussed from different points of view.[9,25] When one water contains a soluble compound such as barium chloride and another a compound with an incompatible ion, such as a sulfate, mixing of the waters might be expected to form insoluble barium sulfate. Rather than go to the expense of removing one ion to a tolerable concentration, it is usually considered more economical and expedient to complex the metallic ion by adding a sequestering or chelating agent. The complex phosphates are used extensively for this purpose.[16] Recently there has been a trend toward the use of organic chelating agents, such as citric and acetic-acid derivatives, especially various salts of ethylenediamine tetraacetic acid.[32] Complex phosphates usually are employed for preventing the precipitation of carbonates and the sequestration of barium to prevent barium sulfate formation when two waters are mixed. The citric- and acetic-acid compounds are used more commonly to chelate ferrous iron.

Despite the common use of sequestering and chelating agents, there is a distinct lack of published laboratory and field data on the comparative efficiencies of such agents in complexing specific metallic ions in waters of varied composition.

4. Detergents. Much interest has been evidenced during the past several years in the use of wetting and surface-active agents for increasing the injectivity characteristics of water and improving the efficiency of oil displacement. Technical literature has described the results of laboratory and field tests with various detergents.[14,17,20,21,32] The consensus regarding the utility of detergents as flood-water additives may be summed up as follows:

a. Detergents improve water injectivity markedly in the laboratory under controlled conditions.

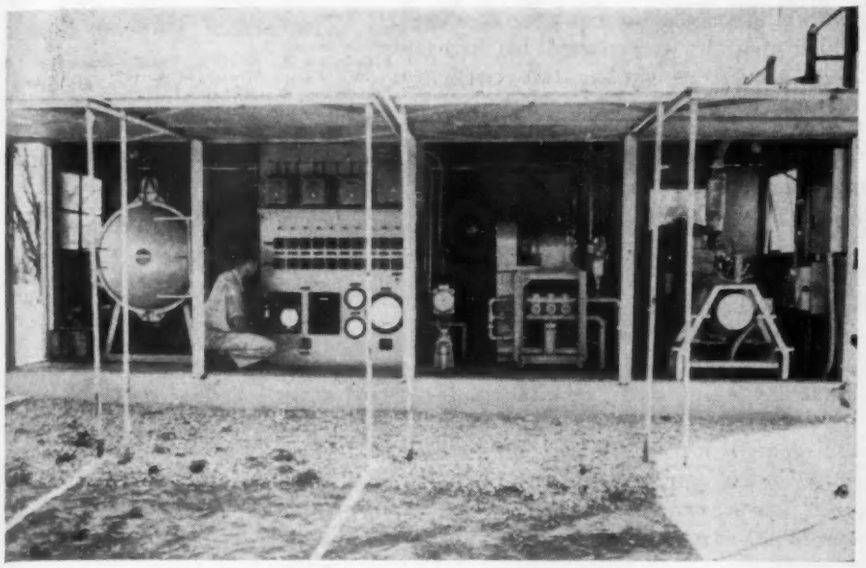


FIGURE 11—Complete portable pilot-flood treating and injection plant. Equipment (left to right) filter, automatic-control panel, horizontal triplex injection pump, gas powered generating plant.

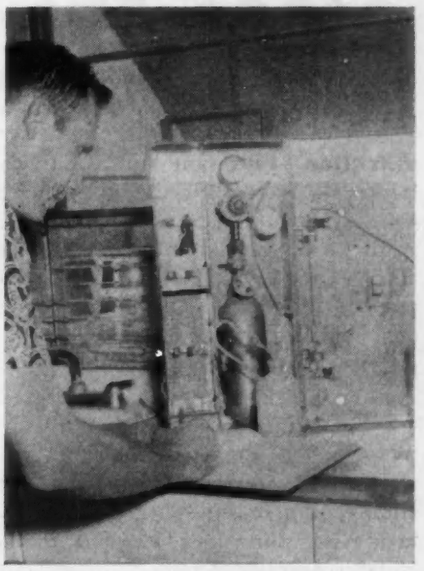


FIGURE 12—Apparatus for test of injection quality of water.

b. The efficiency of oil displacement by water in laboratory tests is enhanced by the addition of detergent solutions.
c. The efficiency of oil displacement by detergent solutions varies with the kind of detergent with "built" nonionics, pure nonionics, anionics, and cationics in general descending order of efficiency.
d. Field results have not been as encouraging as those obtained in laboratory tests. It has been demonstrated that improvements in injectivity or oil production may be obtained by the use of detergent solutions under specific circumstances. Whether general increases can be obtained is a question that has not yet been proved.

The complex phosphates, which possess detergent properties, as well as sequestering ones, sometimes are used successfully as "builders" for synthetic organic detergents.

Chemical Feeding. Chemical feeders are predominantly of the dry, proportioning type which utilize a hopper, stirrer and adjustable orifice. A modification of this type of feeder is shown in Figure 5. This feeder discharges lime and a coagulant from separate hoppers onto a variable-speed conveyor belt. Coagulant is discharged onto the belt through a fixed orifice; the amount added is regulated by varying the speed of the belt. The amount of lime added is regulated by means of an adjustable orifice.

One common difficulty in the addition of dry chemicals is incomplete solution of the salt, which causes a loss of treating agents. Various methods are employed to insure complete solution of the chemical, including mixing with water jets and the use of mechanical agitators. One novel apparatus used for this purpose is a conventional washing machine with an oscillating agitator, shown in Figure 6. The cost is nominal and the efficiency of mixing and solution are high.

Sedimentation. There is a definite trend toward the use of sedimentation tanks. Usually a series of concentric baffles, a large-diameter, slowly rotating agitator and sludge-drawoff facilities are used. Regardless of mechanical construction and operation, the purpose of such units is to introduce raw water at one point and discharge treated water, essentially free from suspended matter, at another point. Although most treating and sedimentation tanks are of standard commercial design, some are especially designed and fabricated for specific installations, Figure 7. In this unit, treated water is distributed around the periphery of the tank through a perforated cement-asbestos loop, going under one baffle and over another into a center well from which the water flows to the filters.

One unique feature of this unit is the desludging mechanism. A three-line, oscillating "vacuum cleaner" rotates to about 300 degrees of the circumference of the tank in about a two-hour period before automatically reversing the direction of rotation. The sludge drawn from the bottom of the tank is discharged continuously into a sludge pit.

In Figure 8 the sedimentation tank described may be seen in the background. In the foreground is a mixing and flocculation basin. The stream of water containing treating chemicals enters the basin at the near, right corner and passes around the ends of the numerous baffles before being discharged at the far end to flow into the sedimentation tank.

By no means are all sedimentation facilities tanks; earthen ponds are used extensively. One weak point remaining in the construction of many sedimentation ponds is the arrangement of baffles. A sedimentation pond may have a displacement time of 12 to 24 hours; the actual detention time may be less than 1 hour. Such a situation defeats the primary purpose of using a large pond—that of providing adequate detention time for complete flocculation and sedimentation. Further study of optimum baffle design and arrangement is warranted.

A trend in construction of earthen sedimentation ponds is the practice of lining the sides and walls with asphaltic, membraneous materials,[27] Figure 9. The asphaltic material is applied in sheets, and the cracks between the sides and ends of the sheets are filled with asphalt. The resultant

surface is water proof, resilient, and abrasion resistant. Data are not available on the durability and current comparative cost of this type surface.

Filtration. Filtration still is largely accomplished by the use of pressure sand filters. Variations of this procedure are the use of open gravity filters and crushed anthracite as a filter medium. Slow sand filters remain in use in very few plants.

The most noticeable trend in filtration procedures is the increased use of diatomaceous-earth filters.[1] While not of great magnitude it is a definite and interesting trend. Several filter manufacturers now market precoat and slurry-feed element filters suitable for the use of diatomaceous earth as a medium and embodying non-metallic or corrosion-resistant metallic-alloy parts.

Figure 10 shows one type of diatomaceous-earth filter, mounted on a common base with all other treating and injection units required for a pilot-flood installation. The filter has a Monel shell and employs plastic-cloth covered glass fiber filter leaves. The filter has 75 square feet of area and a rated capacity of 2500 barrels daily, equivalent to 1.0 gallon per minute per square foot. A slurry of diatomaceous earth and asbestos fiber is continuously injected to form a filter cake. Backwashing and precoating of the leaves are accomplished in place. The control panel shown with this unit is electrically operated and automatically regulates the flow of influent and slurry, as well as backwashing operations. This unit, complete with injection pump and other facilities, is shown in Figure 11 in place for operation on a pilot flood. The portable treating and injection plant shown here includes, from left to right, the filter, automatic-control panel, filter-slurry mixing and feed tanks and pump (behind control panel), horizontal triplex injection pump with variable-speed drive, and a 37.5 KV amp., gas-powered, 220-volt generating plant. Two 130-barrel capacity steel tanks have pipe skids mounted parallel to the long axes of the tanks so that they may be loaded onto truck beds. One tank is used for raw-water storage; the other is used for storage of filtered water. A laboratory and office building, approximately the size of the treating plant and mounted similarly, completes the pilot-plant equipment, all which may be transported by four large trucks. A similar but larger diatomaceous-earth filter is being used elsewhere for daily filtration of 1500 barrels of water to yield an effluent with zero turbidity by conventional optical methods of analysis.

Other Trends of noteworthy interest in water-conditioning systems are the increased use of automatic controls in injection plants,[23] use of meters with isolated working parts, increased emphasis on routine testing of waters, use of analytical methods in predicting chemical and physical reactions in injection systems,[29,30] and closer control of treating equipment and procedures.

A new test to determine the quality of injection water, from the standpoint of its potential plugging tendencies, has been developed during the past few years. This test measures the reduction in flow as the water passes through a core, filter, or other permeable medium. One apparatus for making this determination with filter paper is pictured in Figure 12. Another apparatus, employing a membrane filter with an average pore diameter of 0.45 micron, has been adopted as a standard by the API Southern District Study Committee on Water Treatment.

The treating of brines for subsurface injection is beginning to emerge as a technology of its own, rather than being the outgrowth of older and less suitable methods of municipal water analysis and conditioning. This technology is still in its infancy. Additional experimental work on new and improved methods of water conditioning is warranted and no doubt will be performed during the next several years.

ACKNOWLEDGMENTS

The cooperation of personnel of the Climax-Brundred Water-Flood Division of Climax Molybdenum Company, The Pure Oil Company, Signal Oil and Gas Company, Sinclair Oil and Gas Company, and Tidewater Oil Company, in permitting the use of information pertaining to water-treating units, is gratefully acknowledged. The author is indebted to James W. Davis, Bureau of Mines, Bartlesville, Okla., for critical review of this manuscript. Paper presented at Symposium on Water-Flooding, held at Urbana, Ill., Oct. 28-30, 1956, and released to WORLD OIL through courtesy of the author and the Illinois State Geological Survey.

REFERENCES

[1] Alciatore, A. F., et al., 1955, Diatomaceous earth filtration of water for subsurface injection: Petrol. Eng., v. 27, no. 5, p. B57.

[2] Allred, R. C., 1954, The role of microorganisms in oil-field water-flooding operations—bacterial control on North Burbank Unit water flood, Osage County, Okla.: Prod. Month., v. 18, no. 4, p. 18.

[3] Allred, R. C., et al., 1951, Bacteriological techniques applicable to the control of sulfate-reducing bacteria in water-flooding operations: Prod. Month., v. 19, no. 2, p. 31.

[4] Amstutz, R. W., 1956, Operating problems in water-flood water treatment: Presented Spring Meet., A.P.I. Midcont. Dist., Div. of Prod., Wichita, Kans.

[5] Anderson, K. E., 1956, Standardization of bacteriological tests: World Oil, v. 142, no. 4, p. 176.

[6] Anderson, K. E., and Liegey, F., 1956, Bactericide screening using the strict anaerobe Desulfovibrio desulfuricans: Prod. Month., v. 20, no. 7, p. 30.

[7] Andresen, K. H., and Gardner, F. T., 1950, Requirements of subsurface injection water in oil production: Oil and Gas Jour., v. 49, no. 18, p. 72.

[8] Barton, J. K., and Moss, J. F., 1952, An improvement in the amine-type water treatment: Prod. Month., v. 16, no. 9, p. 25.

[9] Bernard, G. G., 1955, Effect of reactions between interstitial and injected waters on permeability of rocks: Prod. Month., v. 20, no. 2, p. 126.

[10] Bernard, G. G., 1950, Problems encountered in conditioning water for subsurface injection: Oil and Gas. Jour., v. 49, no. 23.

[11] Blair, J. V., 1951, Treatment of produced salt water prior to underground disposal in sand formations: Oil and Gas Jour., v. 49, no. 42, p. 176.

[12] Breston, J. N., 1950, Conditioning water for secondary recovery in Appalachian fields: Oil and Gas Jour., no. 16, p. 159.

[13] Breston, J. N., 1949, New chemical treatment of flood water for bacteria and corrosion control: Prod. Month., v. 13, no. 7, p. 16.

[14] Breston, J. N., and Johnson, W. E., 1951, Experiments with wetting agents in the Bradford field: Prod. Month., v. 10, no. 1, p. 24.

[15] Brewster, F. M., Jr., et al., 1955, The deaeration of water with natural gas: Prod. Month., v. 19, no. 9, p. 18.

[16] Burcik, E. J., 1954, The inhibition of gypsum precipitation by sodium polyphosphates: Prod. Month., v. 9, no. 1, p. 42.

[17] Calhoun, J. C., et al., 1951, A review of laboratory experiments on wetting agents for water flooding: Prod. Month., v. 10, no. 1, p. 15.

[18] Crawford, P. B., 1955, Aeration with combustion gases: Prod. Month., v. 20, no. 1.

[19] Doscher, T. M., and Tuttle, R. M., 1954, The preparation of a subsurface injection water from a sour brine: Prod. Month., v. 19, no. 1, p. 28.

[20] Dunning, H. N., et al., 1953, Displacement of petroleum from sand by detergent solutions: Bureau of Mines Report of Investigations 5020.

[21] Dunning, H. N., et al., 1956, Field test of a detergent in oil recovery: Prod. Month., v. 20, no. 5, p. 29.

[22] Gregory, V. P., et al., 1950, Chemical treatment of flood waters used in secondary oil recovery: Oil and Gas Jour., v. 49, no. 17, p. 174.

[23] Guldner, C. M., 1954, Automatic control for water-conditioning equipment: Instruments, v. 27, no. 2, p. 292.

[24] Hart, W. J., and Wingate, R. T., 1955, Removal of sulfides from brine by aeration with exhaust gas from submerged combustion: Presented, 30th Annual Meet. Petrol. Branch, AIME, New Orleans, La.

[25] Headlee, A. J. W., 1950, Interactions between interstitial and injected water—a review: Secondary Recovery of Oil in the United States, Amer. Petrol. Inst., Second Ed., p. 240.

[26] Heck, E. T., et al., 1949, Further field tests on use of corrosion inhibitors and bactericides for secondary flood waters: Prod. Month., v. 13, no. 7, p. 27.

[27] Powell, J. P., 1956, Water flooding of oil sands in Butler and Greenwood Counties, Kans.: Bureau of Mines Information Circular 7750.

[28] Robinson, J. B., 1956, Application of organic inhibitors in water flooding: World Oil, v. 42, no. 2, p. 156.

[29] Stiff, H. A., Jr., and Davis, L. E., 1952, A method for predicting the tendency of oil-field waters to deposit calcium sulfate: Petrol. Trans., AIME, 195, T.P. 3278, p. 25.

[30] Stiff, H. A., Jr., and Davis, L. E., 1952, A method for predicting the tendency of oil-field waters to deposit calcium carbonate: Petrol. Trans., AIME, 195, p. 213.

[31] Stormont, D. H., 1956, California's biggest water-injection project: Oil and Gas Jour., v. 54, no. 54, p. 122.

[32] Torrey, P., 1955, Preparation of water for injection into oil reservoirs: Jour. Pet. Tech., v. 7, no. 4, p. 9.

[33] Voss, N. A., and Nordell, E., 1950, Water conditioning for oil-field flooding operations: Oil and Gas Jour., v. 49, no. 27.

[34] Watkins, J. W., 1955, Design and operation of plants for the preparation of water for injection into oil reservoirs: Jour. Pet. Tech., v. 7, no. 4, p. 17.

[35] Watkins, J. W., et al., 1952, Conditioning water for subsurface injection in Midcontinent oil fields: U.S. Bureau of Mines Report of Investigations 4930, 80 pp.

[36] Watkins, J. W., et al., 1950, Field and laboratory studies methods of conditioning water for subsurface injection: Oil and Gas Jour., v. 49, no. 15, p. 120.

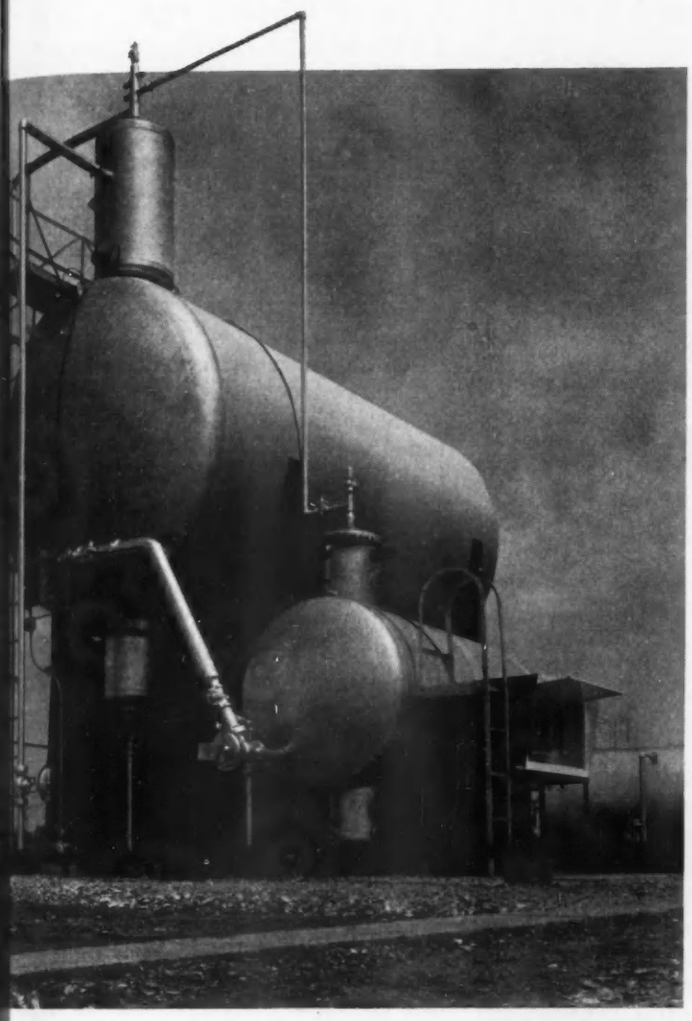
[37] Watkins, J. W., and Wright, J., 1953, Corrosive action on steel by gases dissolved in water: Petrol. Eng., v. 25, no. 12, p. B-50.

[38] Williams, O. B., 1953, Little bugs—big problems: World Oil, v. 36, no. 7, p. 170.

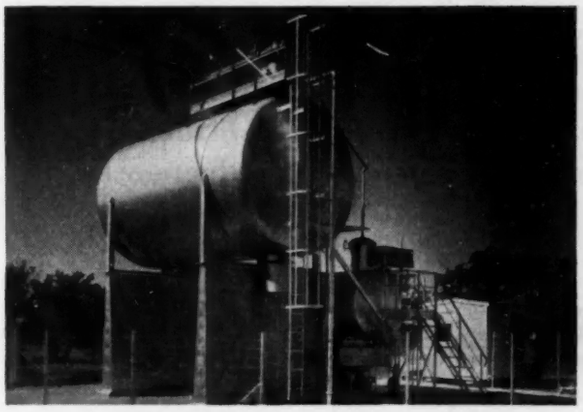
[39] Williams, O. B., et al., 1952, Algicidal effect of certain quaternary ammonium compounds, Prod. Month., v. 16, no. 8, p. 14.

TRANS-OIL* units cut costs

Automatic Transfer of Crude Oil from treated storage to Pipeline



Texas Gulf Coast — 60 barrel metering tank with 400 barrel storage tank; storage tank has an oil and gas separator mounted on its inlet and is equipped with level diverting valves and hi-lo shut down controls.



Southern Oklahoma — 60 barrel metering tank with 444 barrel storage tank; in operation since March of 1956; delivering oil to the pipeline on an automatic basis since November of 1956.

Wyoming — Tandem system comprising 2-100 barrel metering tanks providing continuous delivery to the pipeline. The system uses lease storage tanks as volume storage ahead of the Trans-Oil metering tanks.

National's packaged LACT unit assures fool-proof, dependable, economical, continuous operation.

- Fully automatic measuring and delivery to the pipeline.
- Pipeline run can be continuous or scheduled as required.
- Simple design and construction mean minimum maintenance.
- All valves and controls are fail-safe.
- More accurate, cleaner lease operation.
- Operates pneumatically, electrically or in combination as lease facilities dictate.
- Lease labor can be used for more productive duties.
- Reduces office accounting costs to producer and purchaser by measuring Net Barrels instead of Feet and Inches.

*TRANS-OIL is a trademark of National Tank Company.

It's a National®

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

WATER-FLOOD REPORT

Operators in the Bradford (Penn.) area have saved millions in water costs, reduced lifting costs, and increased production by . . .

Selective Plugging Of Input Wells

By Dr. Holbrook G. Botset and Paul F. Fulton
University of Pittsburgh, Pittsburgh, Penn.

A PROGRAM of selectively plugging water input wells in the old Bradford, Penn., area proved so successful that operators saved more than $3,727,000 in water costs. Other benefits included reduced lifting costs and repairs, etc., as well as a substantial increase in income resulting from the extra oil produced. The properties involved in the nine-year program contained a total of 364 producers and 371 inputs of which 205 were treated at an average cost of $82.13. The over-all summary of the selective plugging operations is contained in Table 1.

One of the problems facing water-flood operators is that of produced water-oil ratio, which, beginning with water break-through, continues to increase throughout the remaining life of the flood. This water production affects the efficiency of operations in several ways:

1. It necessitates large sources of water.

2. It increases water treating and pressure plant costs.

3. It increases lifting costs.

4. It creates serious disposal or re-handling problems.

Therefore, anything that can be done to reduce water-oil ratios, provided it is reasonably inexpensive and simple to apply, should be of considerable benefit to water-flood operators.

As a result of many laboratory experiments and general consideration of fundamental relationships, it is generally accepted that the flowing liquid behind the water front in a flooding operation is primarily water, producing relatively little oil from the flooded out sand. This is true in a stratum of uniform permeability. In a single stratum of sand, in a pattern flood such as a five-spot, the water front from each injection well reaches the producing well in a single point. As the flood continues, that point or line of initial contact gradually expands around the circumference of the producing well until areas of contact from the four injection wells meet and the well is producing essentially water from that one stratum. It is probably rare than an oil sand of any thickness is of uniform permeability throughout its vertical section. In practically all cases the sand consists of a number of layers of different permeabilities. These permeabilities may vary widely from layer to layer. In many cases there is no vertical permeability between layers. In such cases, each sand layer inherently behaves under water-flood as if it were an entirely separate reservoir.

If there are several layers of sand of different permeabilities in a given pay, the stage of development of the flood pattern in each zone at any time will be a function of the permeability in that zone. When water breakthrough has occurred in the most permeable zone, the flood front in less permeable zones will be at various intermediate positions between the injection and producing wells. If there is a wide range in the various layer or zone permeabilities, the flood front in the tightest zone may have progressed only a short distance from the injection well when water breakthrough has occurred in the most permeable zone. This means that in order to recover oil from the tightest zone, large volumes of water, doing very little useful work, will have to be pumped through the most permeable zone in order to flood out the tightest sand.

In fact it is not at all improbable that in many cases, because of the large water throughput required, the economic limit of the flood will be reached long before the flood in the tightest sand layer has reached the producing well.

Any feasible method, therefore, of reducing the water intake into the sand of high permeability while not restricting injection into the tight sands should be of great value to the operator. For several years some operators have been very successfully using selective plugging techniques which perform exactly this operation.

For nine years, the South Penn Oil Company, Bradford, Penn., has been selectively plugging hundreds of input wells and keeping careful records of the performance of the floods involved. These results are most encouraging and are presented in order to show other operators the very substantial benefits that may be derived from a systematic and carefully conducted selective plugging program.

The mechanical techniques of selective plugging have been described in some detail in the literature and are only briefly summarized here. Advantage is taken of the fact that if water is being injected into zones of differing permeabilities and the injection well is closed in, the tighter zones will back-flow into the zones of higher permeability. By proper timing

and placing of the plugging material, it will be deposited on and in the more permeable zones and will not damage the tight layers. Sometimes several treatments on a single well are advantageous.

The success of selective plugging operations will be indicated by the reduction of the water-oil ratio in the producing wells or by reduction in water injection rates. There are three relatively simple procedures which may be used to measure the effect of the plugging agent on the injection well. All of them involve the comparison of measurements made before the plugging job with similar measurements made after plugging.

The first method is that of determining the pressure fall-off curve for the injection well. The well is closed in and the wellhead pressure versus time is recorded. When the log of the pressure is plotted as ordinate against the time as abscissa, a curve is obtained that is nearly a straight line. This curve is in one sense a measure of the ratio of the tight to the loose sand. If this ratio is low the curve will fall fairly rapidly. If the ratio is increased (by plugging the loose sand) the curve will fall more slowly. Hence, a change in the general slope of this curve indicates the effectiveness of the plugging operation. This is indicated in Figure 1, which shows successive pressure fall-off curves on a well following successive treatments.

A second method of determining whether plugging action has occurred is that of taking the localized injectivity index. A decrease in slope of the injectivity index curve after treatment indicates that plugging has occurred at the sand face.

A third method is the determination of the skin effect at the injection well. This procedure is somewhat more complex to apply, but measures qualitatively any change in over-all permeability at the well sand face.

Of the three procedures, the pressure fall-off method is the one which is sensitive to the selectivity of the plugging action. The other two simply indicate that a plugging has occurred.

Before any selective plugging operations are started, it is very important to be sure that the high water-oil ratios are not the result of pressure parting or mechanical failure such as packer failures, tubing leaks, shot cracks around the packer, etc. Relatively low injection pressures are not necessarily a criterion as to the absence of pressure parting. A case has been cited where parting apparently occurred at a sand face pressure of 0.53 psi per foot.

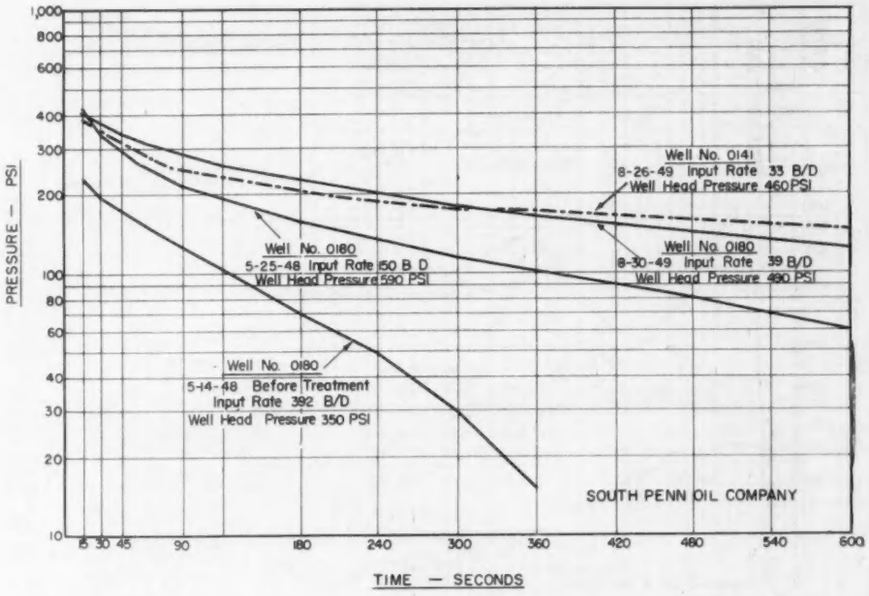

PRESSURE — PSI
TIME — SECONDS
Well No. 0141
8-26-49 Input Rate 33 B/D
Well Head Pressure 460 PSI
Well No. 0180
8-30-49 Input Rate 39 B/D
Well Head Pressure 490 PSI
Well No. 0180
5-25-48 Input Rate 150 B D
Well Head Pressure 590 PSI
Well No. 0180
5-14-48 Before Treatment
Input Rate 392 B/D
Well Head Pressure 350 PSI
SOUTH PENN OIL COMPANY

FIGURE 1—Successive pressure fall-off curves on a well following successive selective plugging treatments.

The most common selective plugging agent used in the Pennsylvania area is an aqueous suspension of resin whose particle size (90 percent less than 1 micron, or 0.0004 inch) makes it particularly effective in the small pores of the low permeability Bradford sand. For formations where pore sizes are larger, plugging materials of larger particle size, many of which are available for this purpose, should be equally effective.

Extensive selective plugging operations have ben carried out for many years by South Penn Oil Company. Since 1946 several leases have been subjected to a selective plugging program. Accurate detailed records have been kept of the performance of these leases before and after plugging. Data are available through the latter part of 1955 for three properties known as

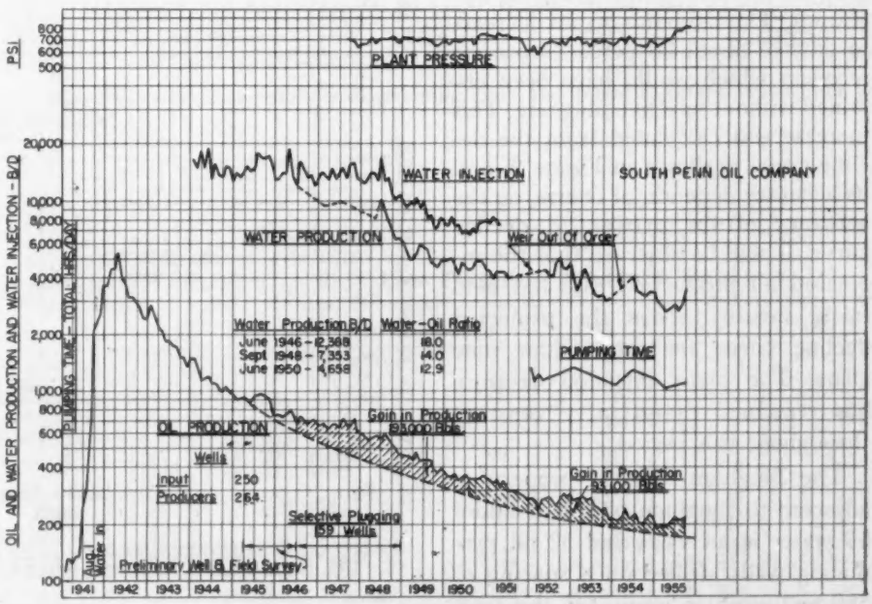


FIGURE 2—Production history of the Bingham 533 lease comprising 832 acres.

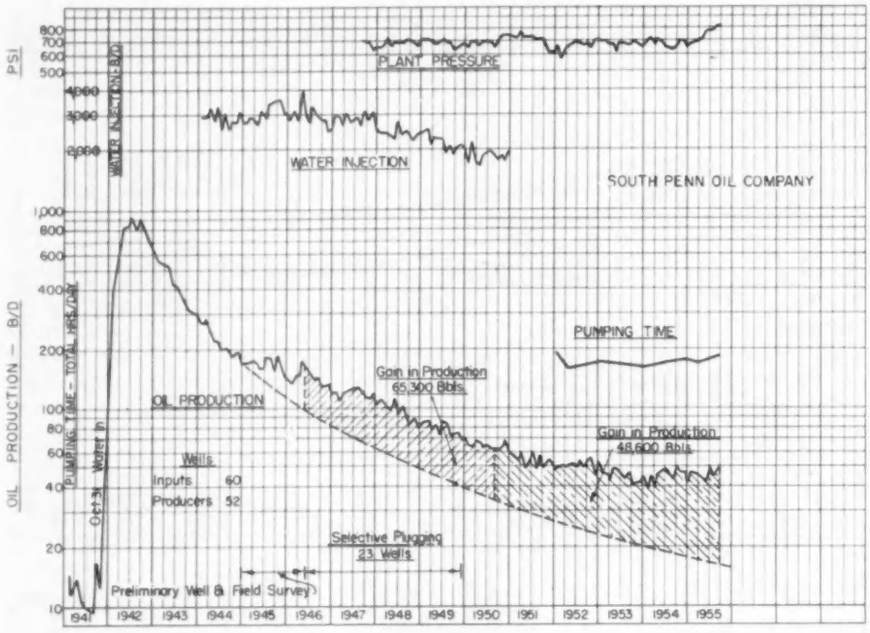


FIGURE 3—Production history of the Bingham 532-544 lease, adjacent to the Bingham 533 and containing 60 water input wells and 52 oil-producing wells. Twenty-three wells were selectively plugged on this lease.

Bingham 533, Bingham 532-554, and Bingham 369.

Bingham 533 comprises 832 acres and has 250 water input wells and 264 producing wells with a spacing of 350 feet input to input. Figure 2 shows the results of the operations on this property. Beginning in 1946, 159 (out of the 250) input wells were selectively plugged. It will be noted that the water-oil ratio ranged from a value of 18.0 to 12.9. It is estimated that 286,100 additional barrels of oil were produced through September 1955 as a result of this plugging operation. This amounts to an increase to date of about 28 percent over the recovery which would have been obtained without selective plugging. This increase was calculated from the decline curve as shown in Figure 2, and its accuracy depends, of course, on the accuracy of the projected decline curve. It will be observed that the increased oil production rate has held fairly steadily above the projected decline curve for more than nine years. The plant injection pressure has remained essentially constant throughout this period.

The Bingham 532-554 property is adjacent to Bingham 533. It contains 60 water input wells and 52 oil producing wells, drilled on a spacing of 360 feet input to input. On this lease 23 water input wells were treated until the water input averaged about 50 barrels per day. Figure 3 shows the results of the work on this lease. The data through September 1955 indicates an increased oil recovery at that time of 113,900 barrels of oil, or about 89 percent more oil than would otherwise have been recovered. The plant pressure on this lease also remained essentially constant over the eight-year period of measurement, while the water injection rate showed a definite decline through 1950.

The third property, Bingham 369, contains 61 water input and 48 producing wells on a 350-foot spacing, input to input. Selective plugging treatment was applied to 23 of the water input wells until their average daily input was 50 barrels per well. Figure 4 presents the results of this series of treatments. Again it will be seen that a substantial increase of production was obtained (40,900 barrels) through September 1955. This is an increased recovery of about 55 percent. The plant pressure also remained nearly constant while the water injection rate declined.

Among the factors which made selective plugging so effective on these leases was the fact that highly permeable strata transmitted so much water that it was difficult to pump off the producing wells in a twenty-four hour period. The effect of selective plugging on pumping time is evident in the curves of Figure 5 which presents a typical example of the pumping time and water injection before and after plugging. These results are typical of several leases. On the Bingham property, the problem wells were treated until their intake was about 50 barrels of water per day. Before treatment, injection pres-

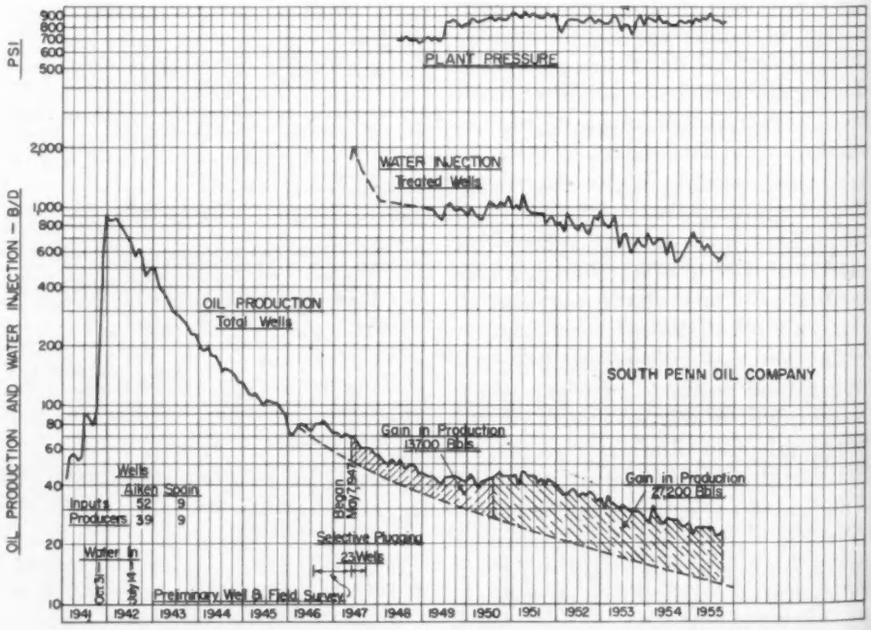


FIGURE 4—Selective plugging treatment was applied to 23 water input wells on the Bingham 369 lease. Results indicated an increased oil recovery of about 55 percent.

sures were held down on some wells because of their high water throughput capacity. This restricted the flooding rate of the tighter strata in these wells. Following treatment full flooding pressure could be applied to these former problem wells with a resulting increase in flooding efficiency in the tighter strata.

In the over-all summary of South Penn Oil Company selective plugging operations through 1954 as shown in Table 1, it will be noted that for the nine-year period, it is estimated that more than 248,467,000 barrels of water were saved, which meant a saving in water cost of more than $3,727,000. This estimate is based on a cost figure of $0.015 per barrel. This is undoubtedly low today, so that the savings today would be greater than those shown. In addition, savings obviously occurred in the reduced lifting costs, equipment repairs, etc., not to mention the increased income resulting from the extra oil production.

The Engineering department of South Penn Oil Company has prepared two charts based on field experience, for three different spacings, by means of which water costs per 5-spot and water costs per acre may be determined for a projected flood. These charts are based on a 100-acre development, so that applying them to developments of other sizes is a matter of simple arithmetic. The first chart (Figure 6), shows the relation between daily input rate per well, total number of input wells, and total water cost per acre based on a 15-year operation. For example, if the input rate is to be 50 barrels of water per day into 55 wells on a 100-acre development, the total water cost per acre (based on $0.02 per barrel) would be $3000 for the 15 years.

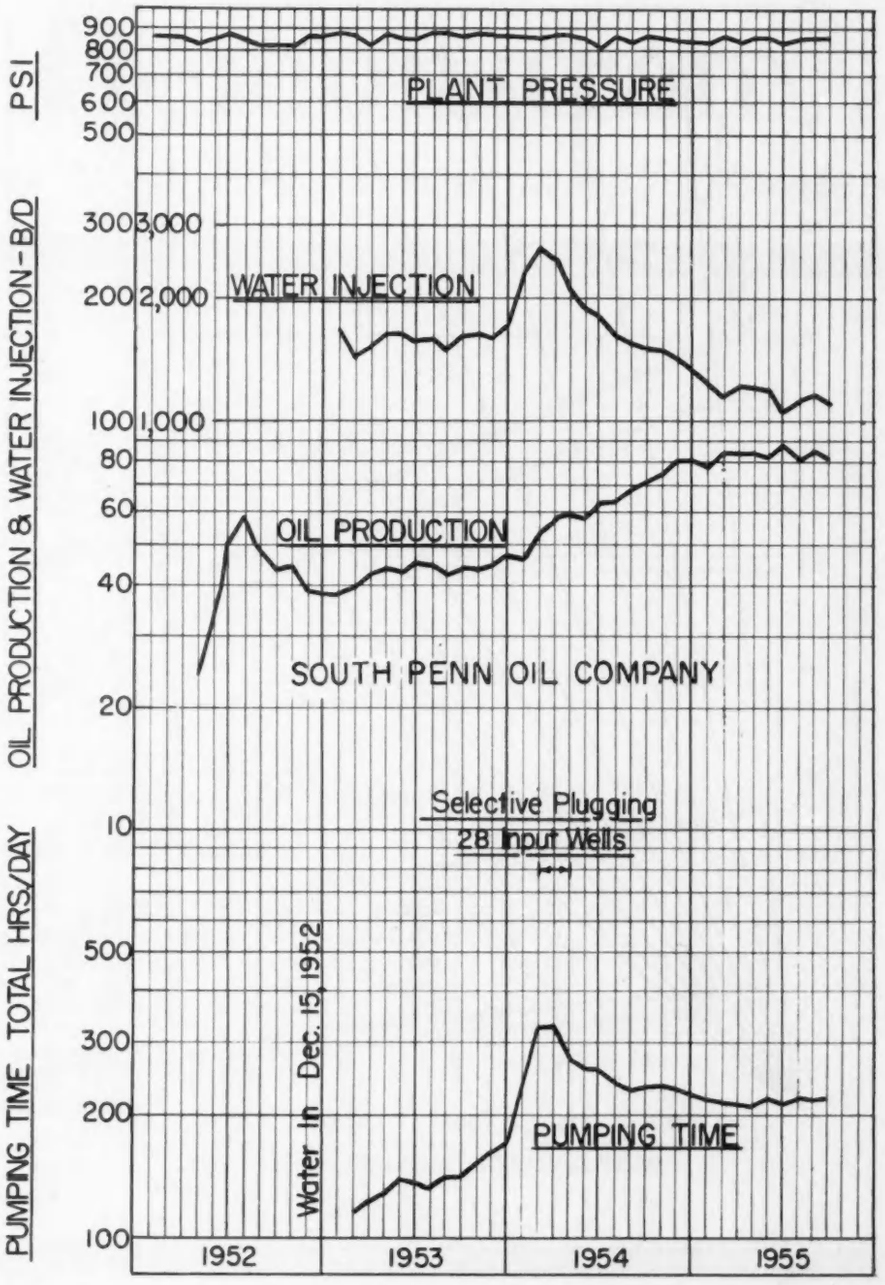


FIGURE 5—Typical example of pumping time and water injection before and after plugging.

TABLE 1—South Penn Oil Company Summary of Selective Plugging Bradford Field

	1946	1947	1948	1949	1950	1951	1952	1953	1954
Total wells treated	102	149	247	322	191	108	141	196	245
Total number of treatments	284	436	642	966	303	292	403	490	673
Total gallons of soap resins used	4,057	8,328	10,010	10,344	3,252	3,713	4,599	5,348	7,643
Average treatments per well	3	3	3	3	2	3	3	3	3
Average gallons emulsion per well	40	56	41	32	17	34	33	27	31
Average Applied Pressure—P.S.I.:									
Prior to treatment	406	427	494	542	550	692	689	803	915
After treatment	487	533	556	554	600	737	730	820	929
Average Rate Intake—B/D/W:									
Prior to treatment	184	278	193	95	68	105	104	80	84
After treatment	98	99	66	48	44	51	51	43	50
Average decrease intake—B/D/W	86	179	127	47	24	54	53	37	34
Total decrease water used—B/D	8,772	26,671	31,369	15,134	4,584	5,832	7,473	7,252	8,330
Total decrease water used—B/Yr	3,201,780	9,734,915	11,481,054	5,523,910	1,673,160	2,128,680	2,735,118	2,646,980	3,040,450
Savings Water Costs:									
Average per year per well	$ 471	$ 980	$ 697	$ 257	$ 131	$ 296	$ 291	$ 203	$ 186
Total per year ($0.015/Bbl.)	$48,027	$146,024	$172,216	$82,859	$25,097	$31,930	$41,031	$39,705	$45,607

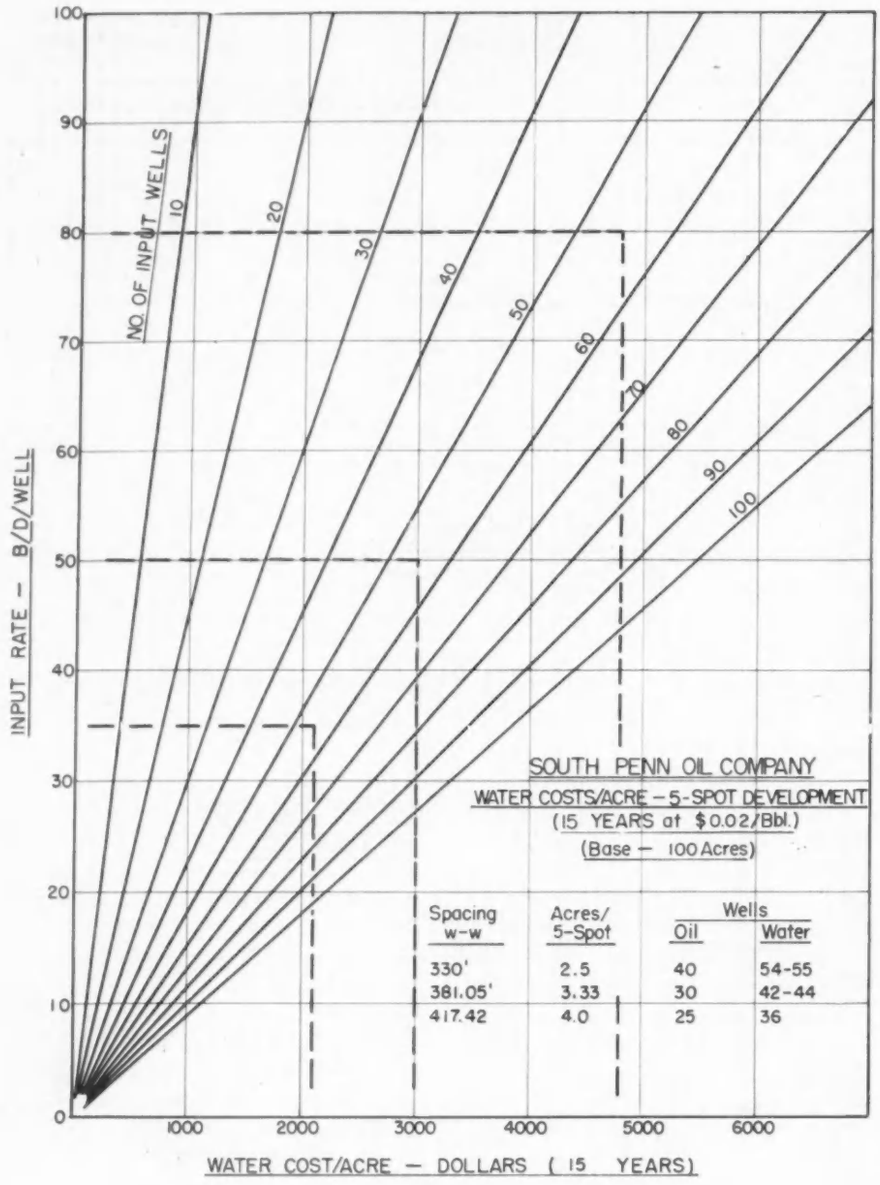


FIGURE 6—Relation between daily input rate per well, total number of input wells and total cost per acre, based on 15-year operation.

From the second chart (Figure 7) it will be noted that for $3000 per acre cost, the total water required for the 100 acres would be about 2,700 barrels. If the oil recovery from this property amounts to 6000 barrels per acre, the water cost per barrel of oil produced would be 50 cents. If the oil recovery is only 2000 barrels per acre, the water cost would be $1.50 per barrel of oil. This is based upon lower water costs which prevailed during the period in which this work was carried out, and would undoubtedly be considerably higher today.

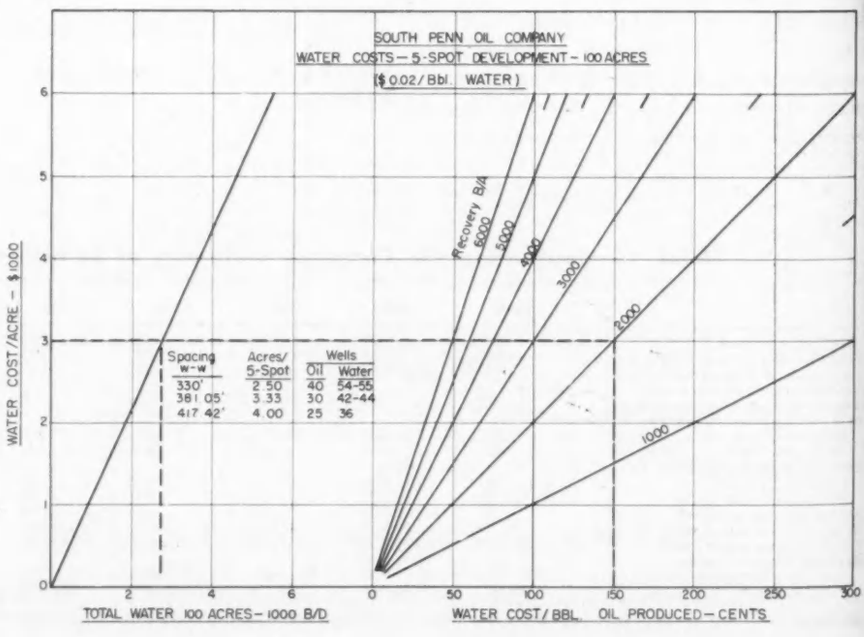


FIGURE 7 (right)—Example showing water costs per barrel of oil produced.

Conclusions. The examples presented here illustrate the considerable economic benefits that can be achieved by a well planned and executed program of selective plugging of water input wells. It is hoped that this discussion will serve to stimulate increased interest in the application of selective plugging to those water-floods which show evidence of abnormal water-oil ratios.

ACKNOWLEDGMENT

The authors wish to thank South Penn Oil Company for making available the technical data on which this paper was based. In particular, we appreciate the co-operation of Harlan Danielson of the Engineering department of that company who has been responsible for the actual selective plugging operations, and who has collected and developed most of the data presented here. The authors wish to express their sincere thanks to Albert J. Sabella in the Petroleum Engineering department of the University of Pittsburgh for his work in preparing the drawings.

Presented at a Symposium on Water-Flooding, sponsored by the Illinois State Geological Survey, Urbana, Ill.

BIBLIOGRAPHY

Danielson, H. H., and Martin, Don, 1950, Selective plugging in the Bradford field: Producers Monthly, v. 15, no. 1, p. 15-27.

Dickey, Parke A., and Andresen, K. H., 1945, The behavior of water-input wells: API Drilling and Production Practice, 1945, p. 34-58.

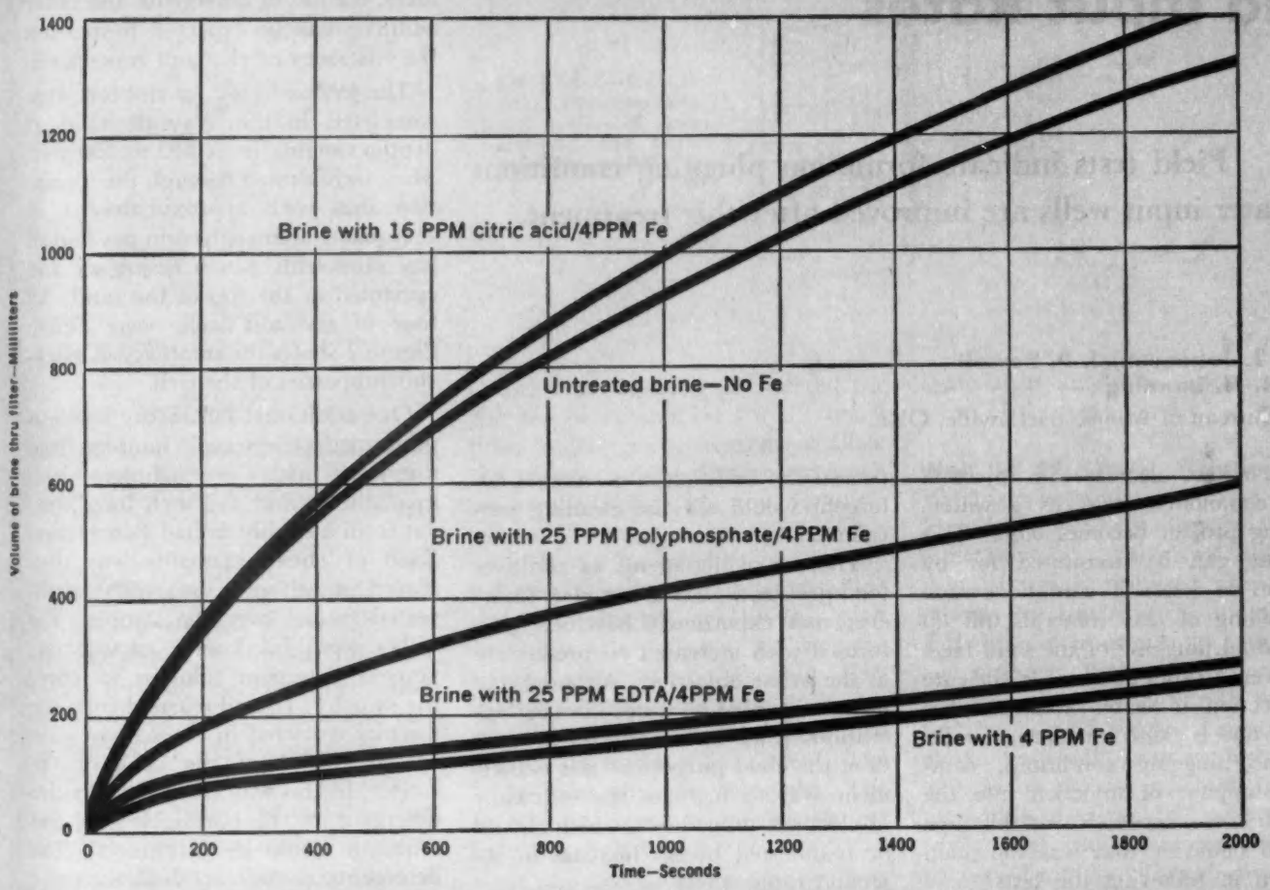
Joers, J. C., and Smith, R. V., 1954, Determination of effective formation permeabilities and operation efficiencies of water-input wells: Producers Monthly, v. 18, no. 7, p. 21-28.

Martin, D., Andresen, K. H., and Ellenberger, F. W., 1947, Recent advances in selective exclusion of water in input wells: Producers Monthly, v. 11, no. 6, p. 18-30; also, API Drilling and Production Practice, 1947, p. 113.

Yuster, S. T., and Calhoun, J. C., Jr. 1944, The selective plugging of oil sands: Producers Monthly v. 8, no. 7, p. 31-37.

Results Demonstrate

flow rates by adding citric acid to your injection water



If you want to stop iron from plugging sandface pores, add citric acid to *your* injection water. *Pound for pound, citric acid not only sequesters iron better but also at less cost than any other agent.* It's nontoxic, safe to handle, and works even in high calcium waters.

Pfizer supplies huge amounts of citric acid for a multitude of industrial uses throughout the world. This large volume production assures you of receiving all the citric you need without delay. For further information on preventing injection well plugging with Pfizer Citric Acid write to:

CHAS. PFIZER & CO., INC.
Chemical Sales Division
630 Flushing Ave., Brooklyn 6, N.Y.

Branch Offices:
Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.; Dallas, Tex.

Manufacturing Chemists

Pfizer

for Over 100 Years

WATER-FLOOD REPORT

Detergent and Citric Acid Aid Input Rates

Field tests indicate formation plugging conditions in water input wells are improved after this treatment.

By R. T. Johansen, J. P. Powell and H. N. Dunning
U. S. Bureau of Mines, Bartlesville, Okla.

A GRADUAL decrease in injection rates commonly occur as a waterflooding project becomes older. This decrease can be accounted for by changes in reservoir conditions such as swelling of clay minerals, fill up or gradual plugging of the sand face. However, a rapid decrease in the rate of injection indicates abnormal behavior and is cause for alarm. Under extreme plugging conditions, complete stoppage of injection into the formation can result. It was this type of well behavior that was the main concern in following the tests.

An accepted method used to alleviate this condition is the backflowing of input wells by closing supply lines to wells and allowing the reservoir pressure to force water back into the wellbore and to the surface. If backflowing is not successful, a string of smaller diameter pipe sometimes is run inside the casing to flush the sand face with a water spray. Another quite common, but more drastic, treatment is to inject acid into the wellbore to dissolve the extraneous matter, or even part of the reservoir material, in an attempt to restore the permeability of the sand immediately around the wellbore. Any of these procedures can be coordinated with bailing and swabbing for cleanout purposes. Since the effectiveness of these cleanout methods depends on the ability to flow water back and forth through the sand face, it appeared the addition of a suitable detergent would aid the cleaning procedures.

The use of detergents as additives for injection waters is not new. However, most experiments have been performed with increased oil production as the prime objectives. Although the ultimate goal of all water-flooding operations is an increase in oil production, the chief purpose of this experiment was to increase the efficiency of cleanout procedures, which should be manifested by an increase in injection rates.

The test site was located on the Bonaventure Oil Corp.'s Wayside Flood 1 located in the northeast part of Washington County, Oklahoma. This site was chosen because it offered test wells with known histories that showed symptoms indicating a detergent would help. A map showing the relative location of the wells and their status at the time of treatment is shown in Figure 1. The test wells had been treated with various acids and bailed previously, so the expected effect of bailing and shutting in the wells was known.

An abnormally rapid decrease in injection rates, early in the history of the flood, indicated a plugging action rather than a normal pressure buildup in the reservoir. The location of these wells with respect to each other defines a narrow impermeable strip suggesting a geologic cause common to all of the wells of low permeability. If the decrease in injection rates was caused by physical changes within the reservoir, such as clay swelling, then washing the faces of the wellbores would not be expected to improve injectivities. However, if the decrease was caused by deposits of iron oxides or other insoluble salts that mechanically blocked the sand faces, the use of detergents and other additives can be expected to increase the efficiency of cleanout procedures.

The wells selected for this test were completed in the Wayside sand at depths ranging from 540 to 550 feet. They were drilled through the formation shot with approximately 1 to 1½ quarts of nitroglycerin per foot of pay sand with 4-inch casing set and cemented at the top of the sand. All four of the test wells were cored. Figure 2 shows the summary of reservoir properties of the well.

One additional laboratory test was performed on reservoir samples from this same field. Core samples 1-inch in diameter and 1½ inch long were cut from a freshly drilled 4-inch core. Each of these samples was then placed in an open dish with an inverted funnel over the sample. The dishes were filled with enough one percent detergent solution to cover the samples. The oil released from the samples collected in the narrow calibrated section of the neck of the funnel. In this way the most effective detergent for this particular sand and crude oil could be determined. The detergents containing 7-12 moles of ethylene oxide per mole of phenol liberated the most oil. In addition, the ground material which was left in the pores of the sample during coring flaked off and left a clean uniform surface. This scaling effect began almost immediately with the samples containing detergent, however, scaling or oil production was not evident in the samples treated only with water or brines.

The detergent used in this field test is a polyoxyethylated nonionic detergent. This particular detergent had been effective in removing oil from sand in earlier centrifugal-displacement tests.

The citric acid was obtained from a local supply house in granular form and dissolved in water before use.

Pressure-decline and injectivity-index tests were performed at the well-

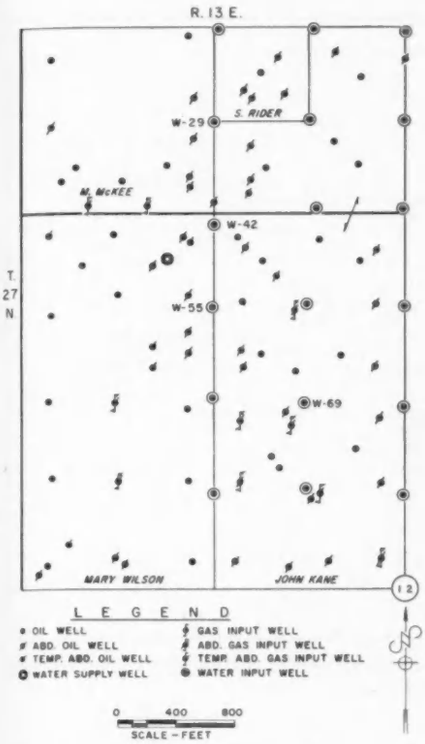


FIGURE 1—Test area of Bonaventura Oil Corporation Wayside flood, Washington County, Oklahoma, October 1, 1956.

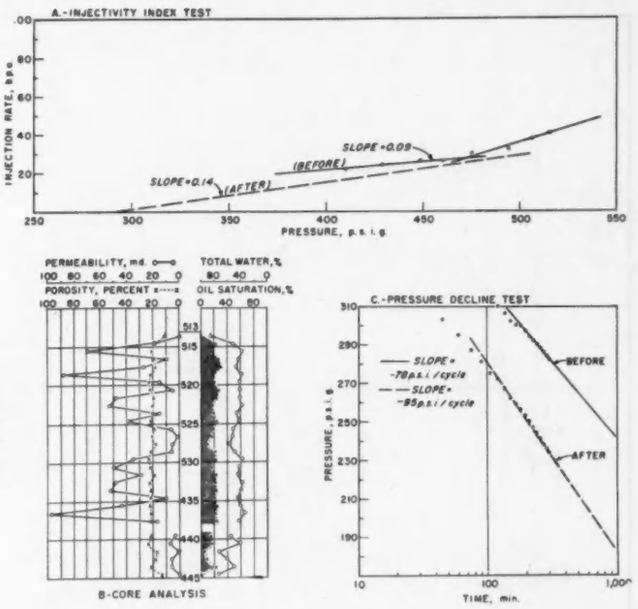


FIGURE 2—Reservoir characteristics and results of core analysis, and wellhead tests, well W-55.

heads prior to treating the wells with detergent. Figures 2, 4, 6 and 8 show a typical plot of pressure-decline data. A time-pressure recording gage is connected to the wellhead and the rate for the well to drop to reservoir pressure is determined. The "skin factor" and effective permeability of the formation surrounding a particular well can be calculated from the rate of pressure decline and physical properties of the reservoir. The skin factor relates the permeability of the zone immediately around the wellbore to that of the formation as a whole. A positive skin factor indicates a zone around the wellbore of lower permeability than that of the surrounding formation. The change in the skin factor to a more negative value after treatment indicates an improvement in well conditions.

Injectivity-index tests shown in Figures 2, 4, 6, 8, are made after the well is shut-in several hours preceding the test to allow the pressure of a well to equalize with that of the formation. The tests are made by recording the rate at which a well will take water at regular increments of increased pressure.

The four input wells selected for the test were shut in for 12 hours prior to detergent treatment, to allow the pressure in the wellbore to reach an equilibrium with the reservoir pressure. Three of the wells were opened and bailed dry immediately before six gallons of detergent was dumped into the wellbore, with enough water to dissolve and mix the solution as it filled the casing. The injection-supply lines were then connected to the wellhead and about two barrels of water was injected. The wells were shut in overnight. The fourth well was not opened, serving only as a control well.

In one of the wells (No. W-55), the bailer was jostled up and down in the casing while the wellbore was partly filled with the detergent solution as a further aid in cleaning the wellbore and shot hole by mechanical agitation.

The next day the wells were swabbed and bailed again. The large amount of iron oxide, drilling mud and chips of stone that came out during the bailing operation was evidence that the procedure did remove considerable insoluble material from the wellbore. At least part of this was probably from the sand face. After bailing the wells as dry as possible, 12 gallons of detergent was poured into the wellhead, the water-supply lines were reconnected and injection was resumed. Ten days after the detergent treatment, wellhead tests again were made to determine the effect of the treatment.

Well W-55. Water injection into W-55 was begun on January 4, 1955. Figure 3 shows the average weekly injection rate in barrels per day, the average weekly wellhead pressure in pounds per square inch, and the injectivity plotted as average rate/average pressure. Water was injected at an average rate of 97 barrels per day for the first 25 weeks. The average weekly wellhead pressure ranged from 339 psi to 550 psi, reaching the latter value during the twenty-fifth week. The rate of water injection decreased rapidly although somewhat erratically during the weeks following, generally reflecting the variations in wellhead pressures. Treating the well with 50 gallons of mud acid, during the first week of the test period, increased the rate of injection slightly. Two additional acid treatments resulted in a substantial increase in the rate of injection. However, the results were rather shortlived; after five weeks the well was taking water at the same rate as that before the acid treatments. During the fourteenth week of the testing period, the well was shut in for a 24-hour period in preparation for the detergent test. A pressure-decline test and an injectivity-index test was made. These tests were repeated after use of the detergent to acid in interpreting the efficiency of the treatment. A summary of the results of

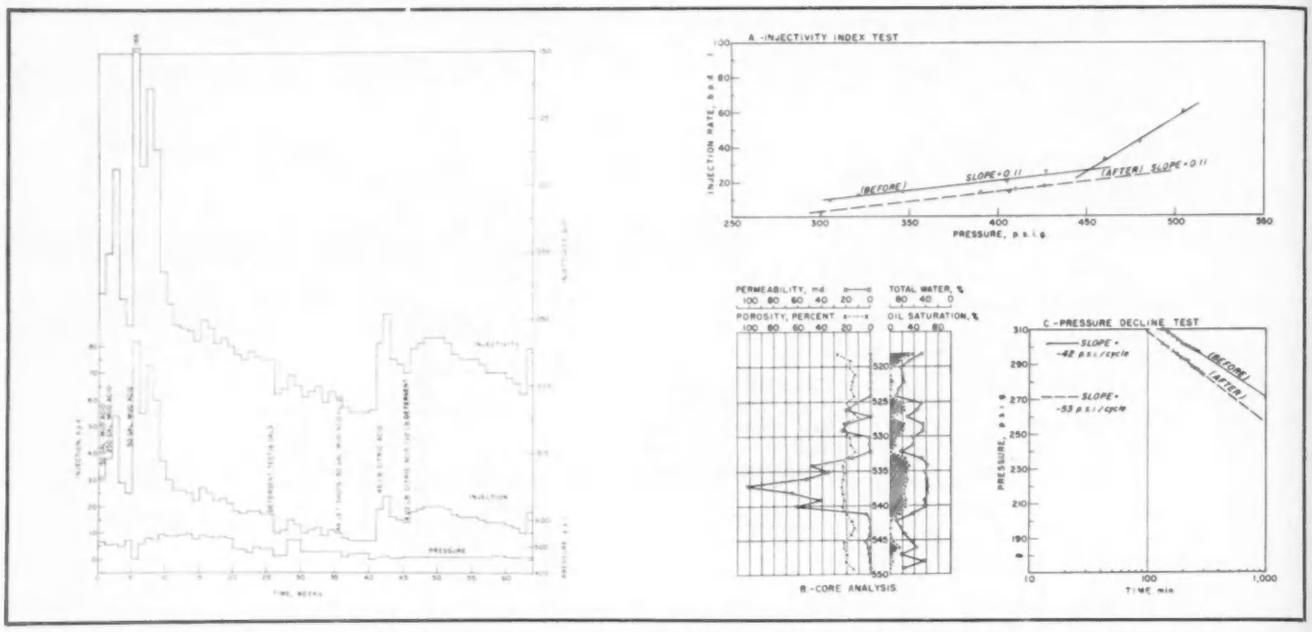


FIGURE 3—Well W-55 average weekly injection rate, average weekly wellhead pressure, and injectivity.

FIGURE 4—Reservoir characteristics and results of core analysis, and wellhead tests, well W-29.

these and similar tests on the other wells is shown in Figure 2.

On February 16, 1956 (twenty-sixth week), well W-55 was bailed and six gallons of detergent plus two barrels of water were run into the well. The solution was mixed thoroughly by agitating with the bailer. The well then was filled to the surface with water, closed to the atmosphere, and one barrel of water was injected at plant pressure, after which the well was shut in overnight. The following morning the well was opened; it backflowed at a high rate after the detergent treatment. Foam and water that flowed into the tank contained clay, sand, and an appreciable quantity of red iron oxide. The well again was bailed dry, and 10 gallons of detergent was poured into the wellbore. After filling the casing with water, the well was connected to the main water-supply line. On March 1, 1956 (twenty-eighth week), the pressure-decline and injectivity-index tests were repeated (Figure 2). A decrease in the injection pressure was accompanied by a decrease in the injection rate. Wellhead tests indicated that the detergent treatment accomplished an increase in the injectivity index and an improvement in the skin factor, in spite of a decrease in the injection pressure.

During the thirty-sixth week, the well was cleaned out, and reshot, using 45 jet shots. It was cleaned again, acidized with 50 gallons of 15 percent hydrochloric acid and reconnected to the main water line. The rate of water injection did not increase. On three days during the forty-second week, 15 pounds of citric acid was dissolved in water and lubricated into the wellhead each day. This treatment increased the rate of water injection from an average of seven barrels per day to averages of 19 and 24 barrels for the next two weeks respectively.

On July 13 (forty-sixth week), the well was treated with a solution of 4½ pounds of citric acid and 1½ pounds of detergent. This treatment was followed by a substantial increase in the rate of water injection (about 36 percent, while the pressure remained steady) which lasted for the next six weeks. It seems unlikely that the small treatment should be given credit for this marked improvement in well behavior. Rather, it probably should be attributed to the cumulative effects of the several treatments.

Well W-29. Water injection into well W-29 was begun on January 5, 1955, and continued at a weekly average rate of 95 barrels per day for the first 15 weeks. However, as in the case of W-55, the average wellhead pressure gradually increased from 264 psi to 546 psi during that period. When the injection rate began to decrease rapidly, the well was acidized with 100 gallons of mud acid. The effect of the acid, together with increased plant pressure, lasted for approximately 10 weeks. The daily rate of water injection declined from a peak of 99 barrels to 32 barrels per day. At that time (approximately 10 weeks later, during the fifth week of the test period), the well was acidized again with very little success. During the 14th week, in preparation for the detergent test, the injectivity-index and pressure-decline tests were made on the well (Figure 4). After the wellhead tests, the injection rate increased greatly for several weeks, indicative of a "breakthrough" of injection water. However, at the time of the detergent test (twenty-sixth week), the well was behaving normally (Figure 5). Prior to the detergent test the well was backflowed, swabbed, and bailed dry. During the backflowing and bailing operation, a considerable amount of iron oxide and dirt was removed from the well. After bailing, 6 gallons of detergent and 2 barrels of water were run into the well. The casing was filled with water, the main water-supply line connected and two barrels of water injected at line pressure. The next morning, pressure on the well was released and it was permitted to backflow. An increase in the rate of backflowing was not shown, although a large quantity of iron oxide was present in the effluent. After bailing and pouring 10 gallons of detergent into the casing, it was then filled to the surface with water. The wellhead was reconnected to the main water-

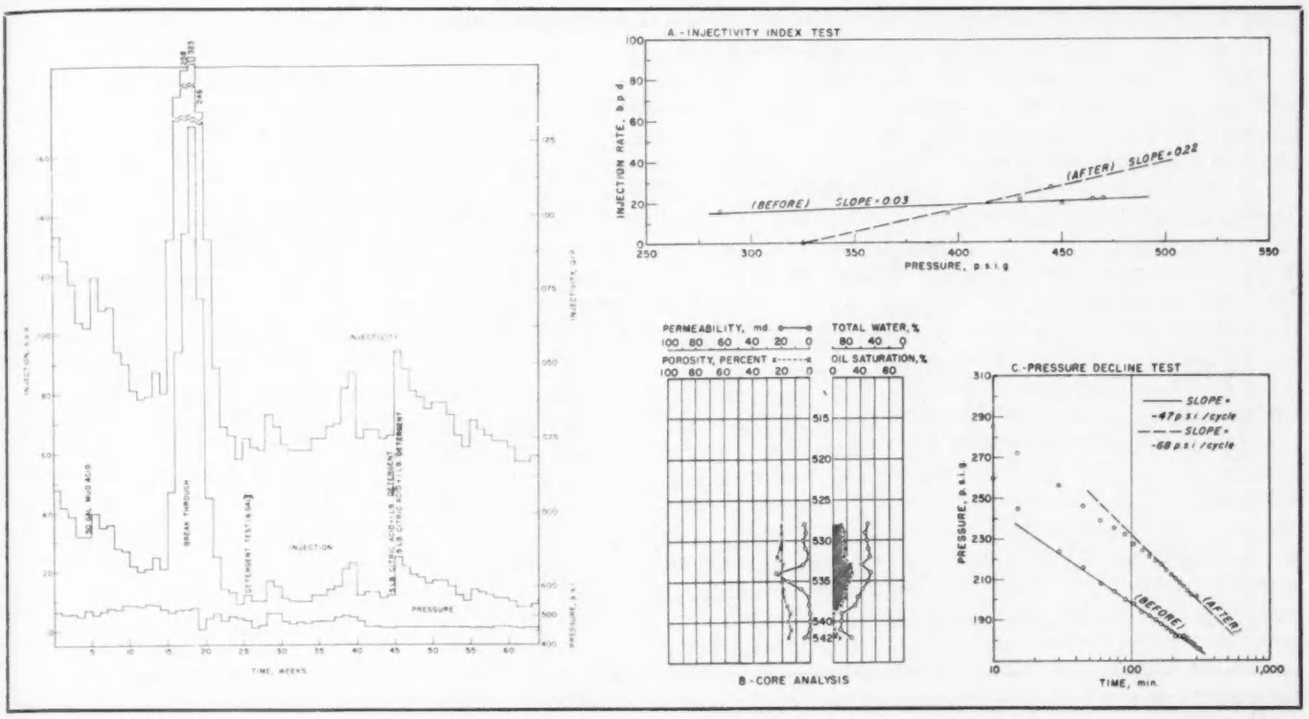


FIGURE 5—Well W-29 average weekly injection rate, average weekly wellhead pressure, and injectivity.

FIGURE 6—Reservoir characteristics and results of core analysis, and wellhead tests, well W-69.

supply line and normal injection was resumed. The injection rate remained constant during the next two weeks, while the injection pressure decreased about 50 psi. A considerable increase in injection rate, accompanying a pressure increase, was then observed.

During the thirty-seventh week of the test period, the well was backflowed prior to an increase in the operating pressure, which increased the rate of injection for about two weeks. This injection rate declined quickly, although the higher pressure was maintained. Five weeks later (forty-fifth week), a mixture of 5 pounds of citric acid and 1 pound of detergent was injected through a lubricator. The treatment was repeated after the well was shut in for 24 hours. The input rate increased from an average of eight to 25 barrels per day. This increased rate was maintained for about 16 weeks at a wellhead pressure of 460 psi, the lowest pressure in 13 weeks.

Well W-69. Water injection into well W-69, shown in Figure 7, was begun on December 16, 1954, and continued without interruption at an average rate of 95 barrels per day for the first 31 weeks of operation. The wellhead pressure increased from an average of 350 psi to more than 490 psi during this period. A decrease in the plant pressure at that time emphasized the decrease in the injection rate. The well was acidized with 100 gallons of mud acid during the third week of the test period and with an additional 50 gallons the following week. This treatment, together with a gradually increased wellhead pressure, raised the rate of injection for two weeks, after which it declined slowly.

Injectivity-index and pressure-decline tests were made during the seventeenth week (Figure 6). Nine weeks later, the well was backflowed and bailed. Six gallons of detergent was poured into the well with enough water to dissolve the detergent. The casing was filled to the surface, and approximately one barrel of the detergent solution was injected into the formation under pressure. The well was then shut in overnight. The removal of some drilling mud and a large amount of iron oxide was observed the next day when the pressure was released. Backflow rate was approximately twice as that before treatment. The well again was bailed dry and 10 gallons of detergent were poured into the wellbore. After sufficient water had been added to fill the casing, the main water-supply line was connected and normal injection was resumed. The daily rate of injection increased from approximately 12 barrels at 460 psi to 16 barrels at an average pressure of 445 psi. After a few weeks of operation (twenty-eighth week), a second series of injectivity-index and pressure-decline tests was made to evaluate the results. The results of these tests are shown in Figure 6.

The thirty-sixth week a drilling rig was moved-in and the well was bailed. Fifty gallons of 15 percent mud acid was poured into the well; it was filled with water and permitted to stand over night. The following morning the well was bailed again and 50 gallons of the acid was poured into the well. Again the well was filled to the surface, reconnected to the main water-supply line and regular water injection resumed. The daily rate of injection increased slightly from 11 barrels at 463 psi to 16 barrels at 465 psi.

Four weeks later (forty-first week), a series of treatments was made using citric acid. A solution of 10 to 12 pounds of citric acid in water was lubricated into the well on six consecutive days. A slight increase in the rate of water injection, accompanying an increase in pressure, was observed. Three weeks later (forty-fourth week), the well again was treated with citric acid, using 14½ pounds of acid in three tests. There was not any observed increase in the rate of injection.

The following week another cleaning operation was begun, essentially the same as the original detergent

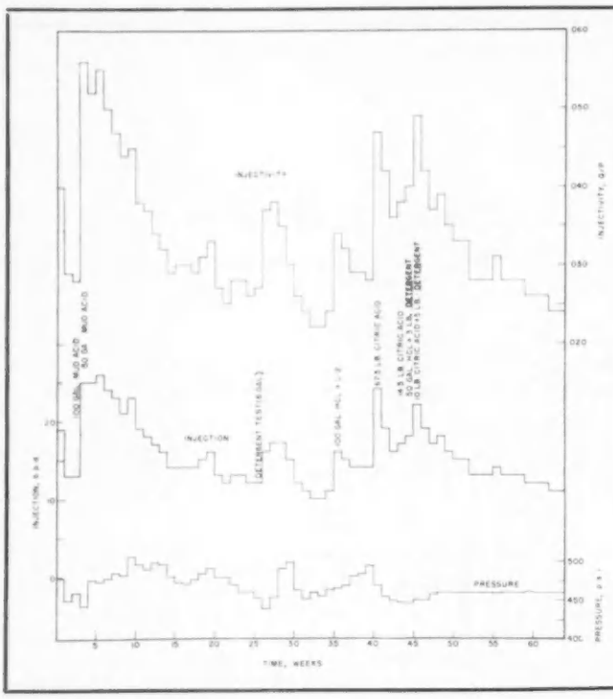


FIGURE 7—Well W-69 average weekly injection rate, average weekly wellhead pressure, and injectivity.

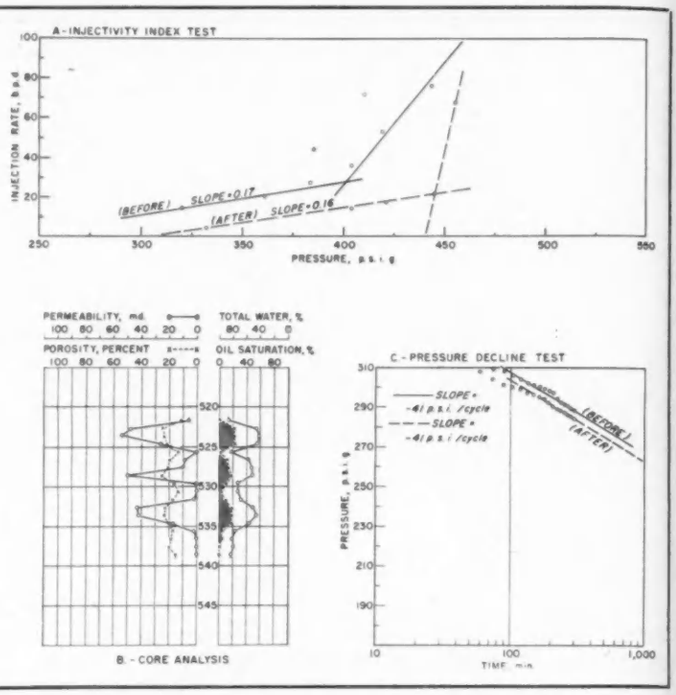


FIGURE 8—Reservoir characteristics and results of core analysis, and wellhead tests, well W-42.

treatment made. The well was opened and bailed dry. A mixture of 50 gallons of 15 percent hydrochloric acid and three pounds of detergent was poured into the well and forced into the sand formation by water pressure. It was shut-in overnight, bailed dry the next morning, and then reconnected to the water system for a 24-hour period. The rate of water injection increased slightly. After bailing dry again, a mixture of 10 pounds of citric acid and five pounds of detergent was put into the well with about 2½ barrels of water. The water-supply line was connected and the solution was forced into the formation with about 1½ barrels of water. The operation was shut-in for 28 hours, permitted to backflow for two hours, repressured to line pressure, shut in for 18 hours, and finally opened for normal injection. This cleaning operation increased the daily rate of water injection from 16 to 22 barrels at 450 psi which was the highest rate obtained from any treatment. The effect was somewhat greater than with the citric-acid treatment after which a rate of 22 barrels per day at 469 psi occurred. The injection history is shown in Figure 7. The well treatment during the forty-fifth week with hydrochloric and citric acids mixed with small amounts of the detergent accomplished a considerable increase in injection rate at a constant pressure. This increased rate of injection persisted for about six weeks.

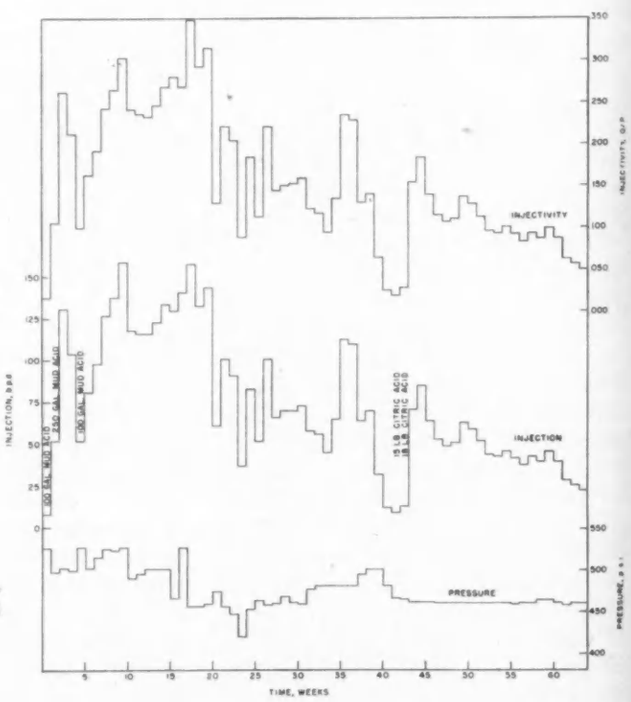


FIGURE 9—Injection record of well W-42.

Well W-42. Well W-42 was selected as a control (Figure 8). Detergent was not used to treat this well, although injectivity-index and pressure-decline tests were made. Water injection into well W-42 began on January 5, 1956. The initial average daily rate of water injection for the first week was 14 barrels at 550 psi. This rate declined gradually to seven barrels per day. The well was acidized with 100 gallons of mud acid, and the daily injection rate increased to an average of 12 barrels. A second treatment, using 100 gallons of mud acid the following week, increased the daily injection rate to an average of 87 barrels. Finally the daily injection rose to an average of 100 barrels but gradually decreased to seven barrels daily at the end of 13 weeks, indicating a rapid plugging of the sand face. The well was acidized again five

weeks later with 100 gallons of mud acid (during the first week of the test period). This treatment was followed by 250 gallons of mud acid the next week. The daily rate of water injection increased to about 130 barrels following this treatment; however, within two weeks the rate had declined to about 50 barrels daily. Another 100 gallons of acid was injected into the well (fifth week). This increased the daily injection to about 160 barrels for a five-week period.

In June of 1956, during the forty-second week of the test period, the daily rate of injection had declined rapidly to an average of 12 barrels. A solution of 15 pounds of citric acid was lubricated into the wellhead, the next week 10 pounds, and the following week eight pounds. These treatments increased injection from 12 to 85 barrels; however, it gradually decreased to approximately 25 barrels. Figure 8 shows the reservoir characteristics and results of the wellhead tests, and Figure 9, the records of injection and treatment over the test period.

Discussion of Results. The evaluation of the results achieved by a field test is complex. The success or failure of the test is seldom determined by a single effect but rather by several interrelated effects. The results obtained in each well have been discussed in detail; therefore, the general observations which apply to all of the wells are emphasized.

The results of the general detergent treatment on the injection rates of wells W-29, W-55, and W-69 were somewhat obscured by unavoidable changes in the field injection pressure. However, the injection rates of wells W-29 and W-69 increased about 20 and 40 percent respectively following the treatment, although the injection pressure had decreased slightly. These results were corroborated by wellhead tests which were made before and after detergent cleanout (Figure 9). These wellhead tests also indicate that the injectivity index and condition of the formation near the wellbore (skin effect) for W-55 were improved by the treatment. Well W-42, which was used as a reference well or blank, exhibited nearly constant wellhead behavior throughout the general test period.

The general test involved bailing and swabbing of the wells. This might be expected to effect some improvement regardless of whether or not it was accompanied by a detergent treatment. However, the later results were obtained by injecting the detergent and citric acid into the well with a small metering pump. These results were generally more favorable than those of the earlier test and indicate the efficacy of cleanout procedures using both a detergent and an acid in an attempt to obtain wetting effects of the oily solids and chelation or solubilization of some of the metallic constituents.

A separate study was made to determine the effect of citric acid and/or detergent upon iron rust. Iron rust obtained from the inside of some discarded and rusty casing was ground and sized. The fraction from 20-40 mesh were used in this test. Six of 12 samples weighed into separate filter dishes were treated with crude oil. Solutions of citric acid, citric acid and detergent, and sodium phosphate and detergent were added to one of each clean and oiled rust samples. The samples were permitted to stand for 72 hours. The solutions were removed and the samples weighed to determine the amount of iron dissolved. The samples again were covered with the desired solutions and allowed to stand another 72 hours. At the conclusion of the experiment (about three weeks), results showed that citric acid and detergent performed the best on clean rust and that sodium phosphate and detergent performed the poorest on oiled rust. The differences between rust and iron oxide in injection lines does not completely invalidate these results. The theory that the detergent removes the oil film allowing the citric acid solution to increase contact and sequester the iron is still plausible. The clean samples containing citric acid were yellow while only the samples with citric acid and detergent solution were yellow when the rust had previously been treated with crude oil.

One benefit received by all the wells treated with detergent was the flotation of drilling clay, bits of rock, and large quantities of iron oxide to the surface. Iron oxides were present in the injection waters in quantities capable of plugging the well by being filtered out on the face of the wellbore. The proportioning of a citric-acid solution into the injection water caused a large increase in the injection rates of the wells. This increase was short lived, probably because the sand was plugged again, since a subsequent treatment of citric acid and citric acid with detergent again caused a more lasting increase in the injection rates. The best treatment might involve a continuous or intermittent injection of citric acid to sequester the iron and a detergent to increase the contact of the acid solution with the solid materials by increasing their wettability to water.

The procedure used to treat wells in this test was selected because the previous history of the field indicated that injection rates were affected by the shutting in and bailing of the wells. This procedure is not necessarily the most effective, neither is it the least expensive. Running a "macaroni" pipe string into the well and spraying the wellbore with detergent would be less expensive than setting a rig over the well. It might also prove to be a better means of cleaning the sand face. This is standard procedure for treating newly drilled wells to remove ground material and drilling mud from the sand face.

Conclusions. The following conclusions are drawn from the described tests.

1. The use of a nonionic detergent in cleaning-out procedures involving bailing, swabbing and backflowing effected moderate increases in injection rates for two of three input wells tested. Wellhead tests indicated some improvement in the condition of the formation immediately surrounding the wellbores.

2. The detergent solution exhibited strong "flotation" effects during the treatment. Drilling mud, chips and rust in large amount were readily removed from the wells during backflowing of the detergent solution.

3. Mixtures of citric acid and nonionic detergent were rather effective for increasing injection rates when proportioned into the wells under pressure.

4. The effects of using both citric acid and detergent are inseparable when used in common solution, but when used singly, the effects are about equal in magnitude and duration.

5. The temporary nature of the increases in injection rates probably indicates inadequate treatment of the injection water.

ACKNOWLEDGMENT

Prepared from material taken from Bureau of Mines Information Circular 7797. The authors gratefully acknowledge the advice and assistance of D. L. Felley, Rohm & Haas Co., Philadelphia, Penn., for supplying the detergent, and the officials and engineers of the Bonaventure Oil Corporation, who made this report possible by furnishing field work and statistical data regarding this project.

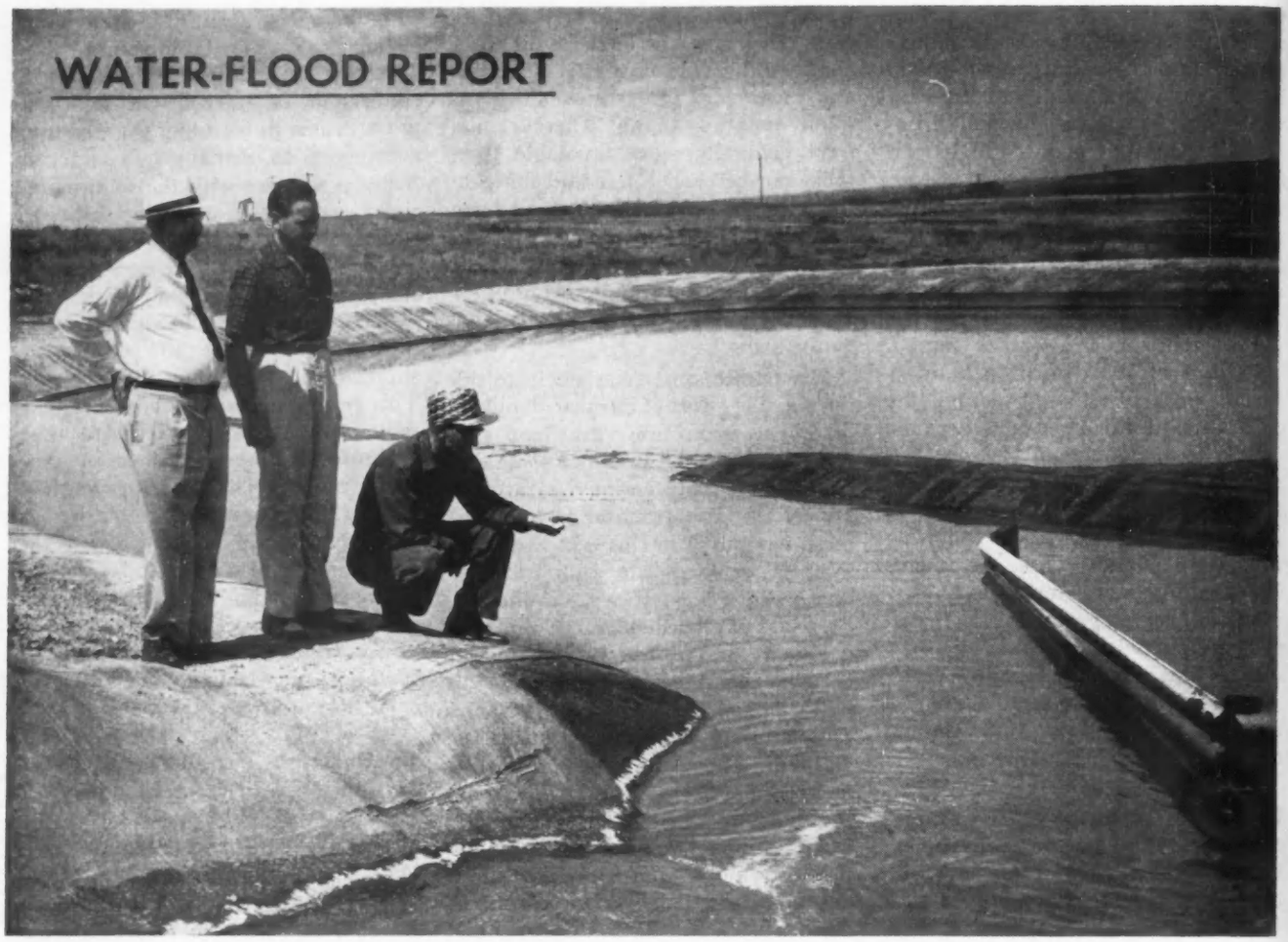


FIGURE 1—The water treating system in use on the Madison water-flood project is the open type, with twin settling ponds. The ponds and ramps are lined with sheet asphalt.

Madison Block Flood in Mid-Continent Outstanding

Each input well is equipped with a throttling type valve and a water meter. In this manner each input well can be operated with efficiency. Pressure taps are made on each well so that the injection pressures can be taken each week.

By R. L. Higginbotham and J. J. Williams
Cities Service Oil Company
Madison, Kansas

AN INCREASE in oil production from 150 barrels per day to 1400 barrels per day marks Cities Service Oil Company's Madison Block water-flood project as one of the most successful in the Mid-Continent area. The project was started in 1948 and two years later was producing only 150 barrels per day. At this time, Cities Service was operating several successful water-flood projects and the experience gained from these other projects was used in planning and developing the Madison project.

History and Geology. The Madison Pool is situated in Sections 10, 11, 12, 14, 15, 22 and 23, T 22S, R 11E, Greenwood County, Kansas.

The discovery well in the field is believed to have been Cities Service Oil Company 1 From in the NW NE NE Sec. 14-22-11, completed January

20, 1923. Initial production from this well was around 250 barrels a day from Bartlesville sand encountered from 1823-1876 feet.

Approximately 132 oil wells and 25 dry holes have been drilled to date within the confines of the pool proper. All wells are completed at approximately the same depth as the discovery well. The productive area of the field approximates 1400 acres.

The producing horizon, locally called the Bartlesville sand, is believed to correlate with the Burbank sand of Oklahoma and is a lenticular sand body, the origin of which is said to be an offshore bar or stream channel deposit and possibly a combination of the two. The Bartlesville sand occupies a position in the stratigraphic column in or near the lowermost part of the Cherokee shale formation of the Pennsylvanian system.

Drilling progressed by stages until 1929 when most of the pool had been developed. All drilling was done by cable tools using steam and electrical power. Oil was produced by primary methods until 1932 when a gasoline plant was built primarily for injecting gas into the producing horizon. Initially the wells were pumped "on the beam" using gas engines or electric motors for power. These were eventually replaced by central band-wheel powers. Most tankage, initially of bolted steel construction, was replaced by wooden tanks in the 1930's.

Production History. Primary production from the Madison Block before gas injection was 5,806,912 barrels. Gas repressuring was started in 1932 and continued until 1952. Increased production from gas repressuring amounted to 1,475,417 barrels of increased oil over a 20-year period. Peak production during gas injection was 740 barrels per day which had declined to 300 barrels per day by 1948. At the time water injection was started in 1948, production had declined to 200 barrels per day. Due to the 20-acre water input well spacing, no significant increase in production was noticed until February, 1950. Production had declined to 150 barrels per day due to conversion of several wells to water input and restriction of gas repressuring. From February, 1950, production climbed steadily to a peak production of 2100 barrels in December, 1955. Curves I and II show graphical water-flood production history and the number of oil wells and input wells. Increased production, due to water-flood, to January 1, 1957, is 2,171,181 barrels of oil. During the water-flood period, 22,580,000 barrels of water have been injected or 10½ barrels of water injected for every barrel of oil so far recovered. To date, 8,800,000 barrels of water have been produced with the oil or a ratio of 4 barrels of water produced per barrel of oil recovered. Total production from the Madison Block including primary, gas injection and water-flood has amounted to 9,453,000 barrels of oil.

Present oil production is 1400 barrels per day from 62 oil wells. The future life of the flood is estimated to be five years during which time the flood should produce another 1½ million barrels of oil.

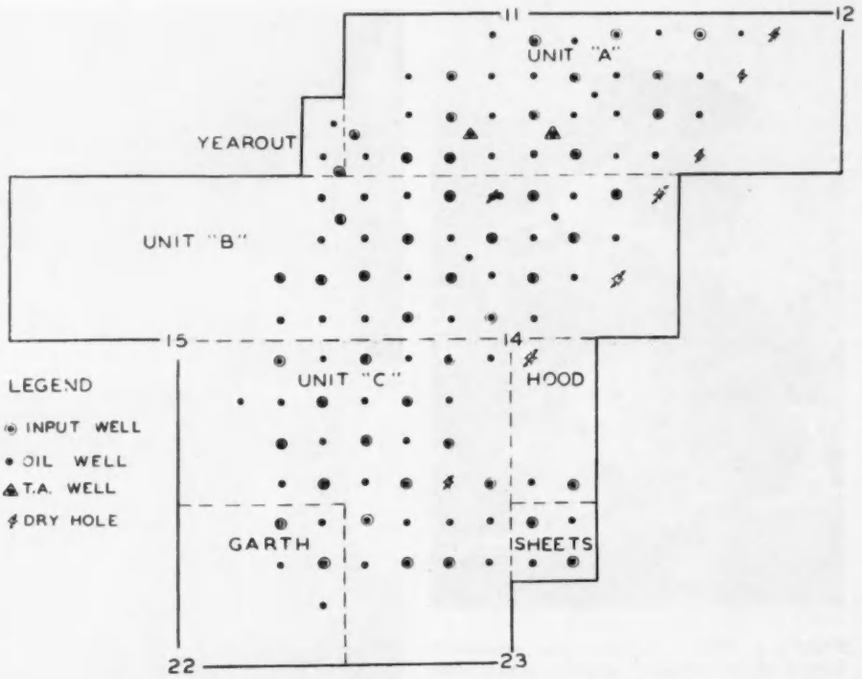


FIGURE 2—Plat shows unitized acreage in the Madison water-flood project.

Planning Water-Flood Development. In the proposed development of the Madison Block for water-flood, the operator was faced with several problems:

- The selection of an effective water-flood pattern.
- Preparation of oil wells for conversion to input wells.
- Development of an adequate water supply for injection.
- Workover of temporarily abandoned wells for production or input.
- Replacement of obsolete production equipment with modern equipment of sufficient capacity to produce increased volumes of oil and water.

Development of Water-Flood. The Madison Block was unitized into three separate units as shown on the plat of the area. A pilot flood was started in the south half of Section 11. Five wells were first converted to input. These were A-2, A-9, A-12, A-17 and A-23. Injection was started in October, 1948, with a closed water supply system which consisted of two wells drilled to the Douglas sand and a salt water producing zone found at a depth of approximately 800 feet. The pumping units on the supply wells furnished the necessary pressure for injection. In 1949, one more Cities Service well was added to the injection system, and at the same time, Magnolia Petroleum Company started injection water into two wells on their lease to the north. In early 1950, a seventh injection well and another water supply well were added to the system.

By 1951, oil production had increased to the point that further development looked encouraging. In accordance with this, in early 1951, ten more wells were converted to water input on essentially a 5-spot pattern and a filter and pump plant

FIGURE 3—During the water-flood production history of the Madison project, almost 22.6 million barrels of water have been injected into the formation. A barrel of oil has been produced, so far, for each 10.5 barrels of water injected. Secondary recovery engineers estimate there is 1.5 million more barrels of oil to be recovered by water-flooding.

FIGURE 4—From the settling tanks, water gravitates into the raw water treater. A combination of lime and ferri-floc is used to treat the water.

was built. The new plant created a demand for more supply water and since it appeared that the Douglas sand would be incapable of furnishing adequate amounts, the Verdigris River, which runs along the north boundary of the project, was selected as a source of make-up water. This created a supply of water which consisted of Douglas water, river water, and the produced water which was being returned to the plant from the producing oil wells.

From this point on, orderly development of the project was continued and the final number of input wells reached 48. Due to decreased rainfall in Eastern Kansas in the years 1951, 1952, and 1953, it became apparent that the supply of river water could not be depended upon for the necessary make-up water so, in 1953, a water supply well was drilled to the Arbuckle lime and a pump was installed. After completion of the Arbuckle water supply, the Douglas water system was abandoned. Since that time, sufficient water has been obtained from the water produced from the oil wells and the Arbuckle water. Water from the two sources is mixed, treated, and filtered at the plant.

Conversion of Wells. Most of the water input wells were converted from existing oil wells. Some new input wells were drilled to obtain more efficient repressuring than could be obtained from the old pattern.

In the old oil wells, none of the pipe had been cemented and the wells had been shot liberally with nitroglycerin. Also, many of them had not fully penetrated the sand upon original completion, due to the fact bottom water was feared. In the process of conversion, the oil string was plugged in the bottom joint and the casing was ripped and cemented above the plug. The well was then cleaned out to total depth and deepened if necessary. Some wells were given a small clean out-shot. Others were not shot or treated at all.

At the start, water was injected down the casing, but due to casing leaks, most of the wells have now been equipped with cement lined tubing and packers. Nearly all of the wells took water satisfactorily at first, but eventually the problem of maintaining or increasing the injection rate was faced. Some of the wells were plugging off due to deposition on the sand face of calcium and iron compounds carried in the injection water.

These wells have been worked over in two ways. The first method is to clean out the well with tools and then wash the sand face with acid, circulating out the spent acid. This is followed by a treatment consisting of magnesium pellets and acid with lactic acid as an additive. This latter solution is pumped into the sand at less than breakdown pressure and then swabbed back until the return fluid is clear.

This method has proven quite successful in wells which originally had a good injectivity rate. The second method of increasing injectivity is accomplished by moving in tools and cleaning out the well and then hydraulically fracturing the sand. This procedure is used in wells along the edge of the pool which had low initial injection rates due to low permeability. This method has been helpful in these tight areas.

Water Treating System. The water treating system, presently in use, is the open type. As shown on the schematic operational diagram, the water produced with the oil is sprayed into a basin at the head of the aeration ramp for a short period of flash aeration and then passes through the skimming pit. The skimming pit (not shown on the diagram) traps small quantities of oil that have broken out

in the aeration process. After leaving the skimming pit, the water flows down the long aeration ramp and into the twin settling ponds. The make-up water from the Arbuckle supply wells is sprayed into the middle of the aeration ramp. The ponds and ramp are lined with sheet asphalt. The settling ponds are so arranged that they can operate together, or one can operate singly while the other is being cleaned.

Two automatically controlled pumps move the water from the ponds to a storage (settling) tank. The water then flows by gravity into the raw water treater (accelerated type) controlled by a float valve on the treater. In the treater, a combination of lime and ferri-floc is used to treat the water. This treated water is then passed through gravity type sand and rock filters into the clear well tank. Four triplex plunger pumps then pump the water into the injection system at a pressure of 700 pounds. The injection system is constructed of cement lined steel pipe.

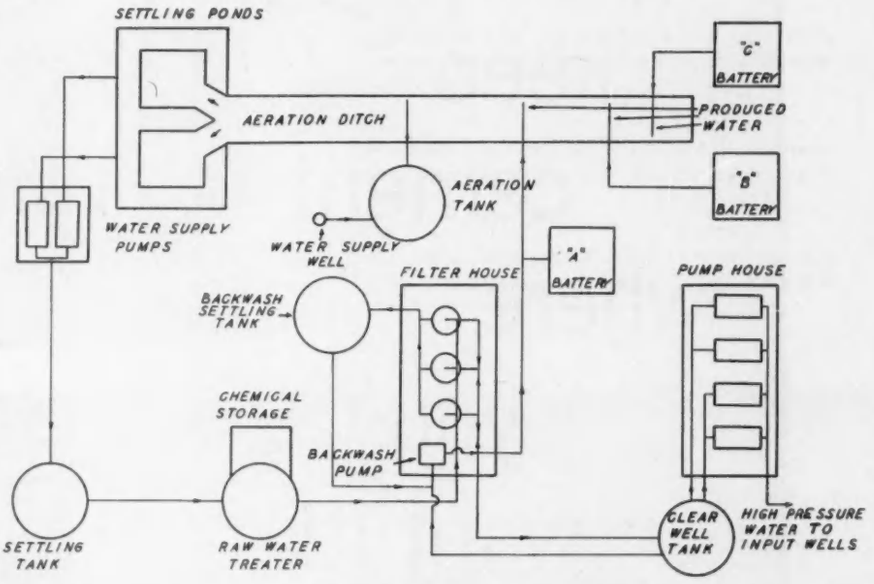


FIGURE 5—Performance curves of the Madison Unit, Greenwood County, Kansas, made by Cities Service Oil Co.

Modernization of Producing Equipment. At the time water-flooding was started on the Madison Block, all wells were being pumped with central bandwheel powers which were driven by gas engines. The wells were equipped with jacks actuated by rod lines.

Each lease in the block had its own individual tank battery. One of the first and most important steps was to unitize the royalty into three major units and three minor ones. After unitization, the entire producing system was modernized by building new welded steel tank batteries and installing a new lead line system of cement lined steel pipe. Each tank battery served several of the original leases and contributed a definite saving in operational labor. The oil wells, that had been temporarily abandoned, were again put in operating condition. As the water drive began to take effect, the central powers were unable to keep the producing wells pumped off so it was necessary to install individual pumping units driven by electric motors.

The increased fluid resulted in more produced water making it necessary to install a salt water disposal system from the tank batteries to the water treating plant. Some of the produced water flows by gravity to the skimming pit and the rest is accumulated in receiving tanks and pumped to the pit. The pump lines have liquid level controls in the receiving tanks to operate the pumps automatically as needed. All disposal lines are constructed of cement-asbestos pipe.

Operating Problems. Each pumping well is treated individually. If it is a part time pumper, a time clock is used in the motor controller to pump the well automatically several times a day, thus keeping the fluid level at a minimum. Each controller also has a time delay mechanism built into it so that in event of a power failure, the motor will start again automatically when the electrical energy is restored, thus, eliminating many trips to the wells by pumper. By staggering the re-starts at intervals of several seconds so that no two wells are started at the same time, peak electrical demand is reduced.

Bottom hole pumping equipment varies with each well. The type that

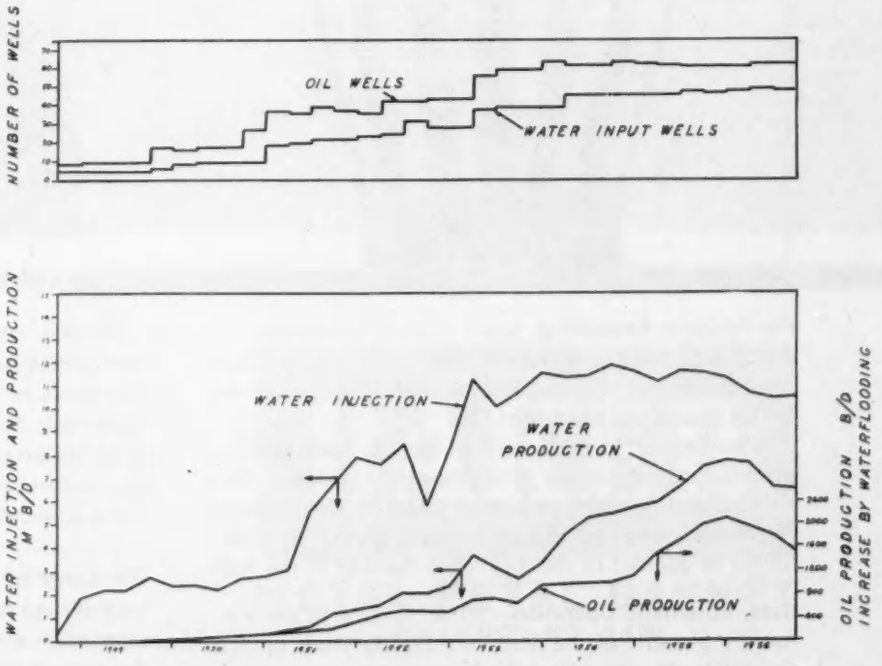
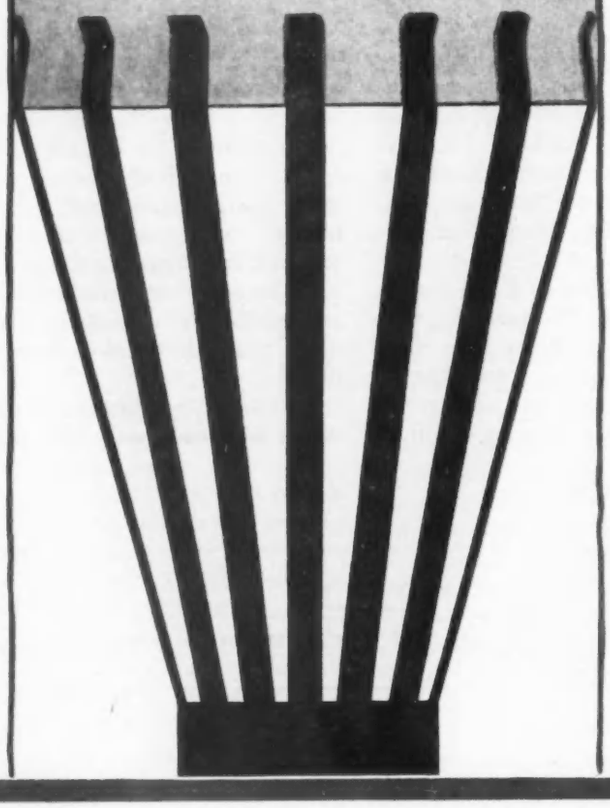


FIGURE 6—Madison Unit water treating system.

keep cement where you want it!



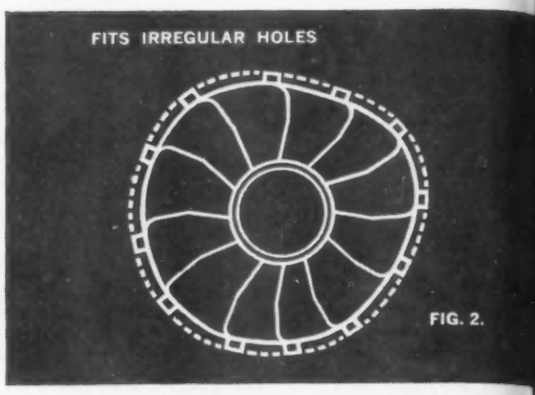


FIG. 2.

FIG. 1.

The reinforced overlapping "petals" form a strong, safe unit which is unaffected by normal well fluids.

For Problem Cementing, where a lower permeable (or weak) zone must be protected from the cement slurry, or from sloughings and cavings, the Baker METAL PETAL Basket is safe and successful.

A number of "petals" made of flexible sheet steel are mounted on reinforcing spring-steel ribs which in turn are mounted on a ring to form the Basket. This all-metal construction provides unusual strength; there is little likelihood of damage to the unit while running in the well.

Safe, Automatic Operation—While running in the well, upward pressure of the fluid (see Fig. 5) tends to close the petals, thus providing fluid passageway between the Basket and the wall of the hole, without distortion or damage to the Basket. As soon as the casing comes to rest, upward pressure by the fluid is relieved and the petals expand to contact the wall of the hole (see Fig. 6). Any tendency of fluid to move downward then presses the flexible petals more firmly against the entire circumference of the hole. Solids which are strained from the fluid serve to build a bridge inside the Basket, which is thus converted into a one-way annular packer of great strength and effectiveness (see Fig. 7).

Fits Large or Irregular Holes—The "Metal Petals" not only expand to contact the entire circumference of large-diameter holes (see Fig. 4) but also pack-off in holes of irregular shape as shown in Fig. 2. The independent action of the individually mounted overlapping petals permits successful use of Baker Metal Petal Baskets in casing programs with minimum clearances (see Fig. 3).

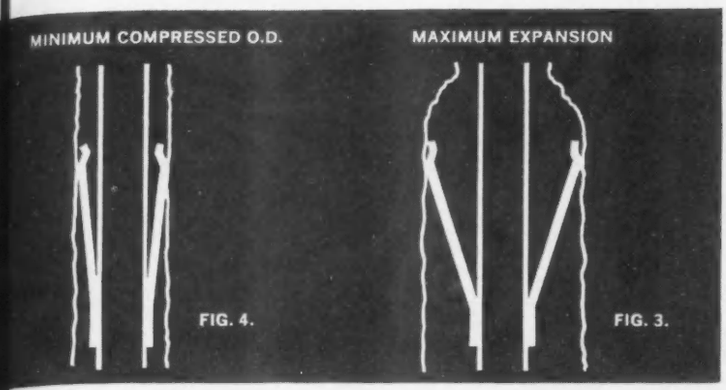
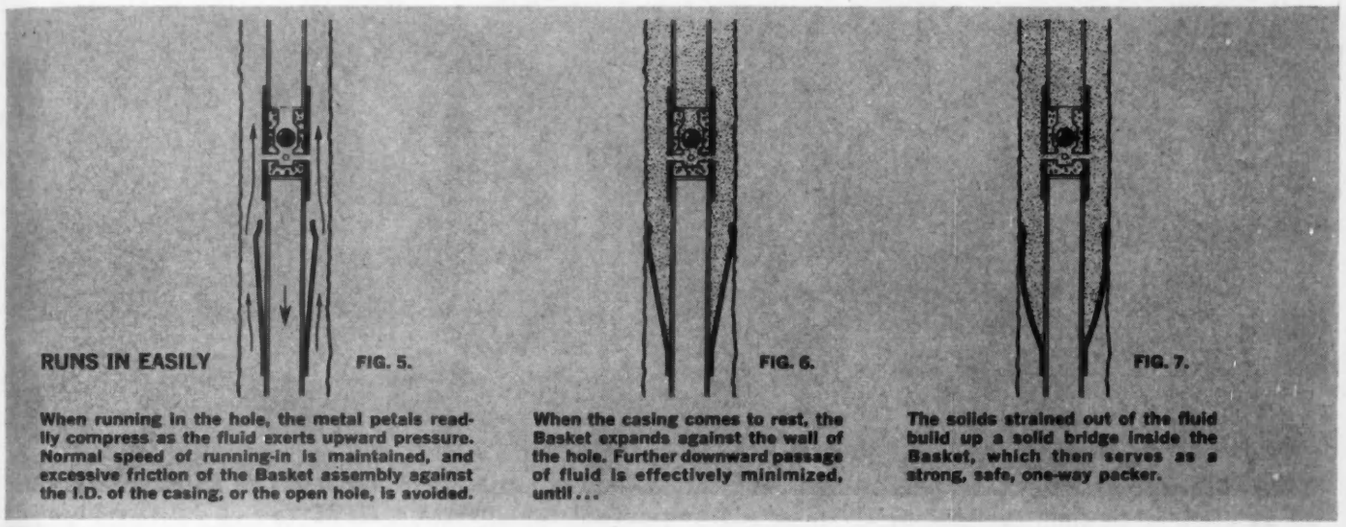


FIG. 2.
FITS IRREGULAR HOLES – The Basket expands to contact the entire circumference of irregularly shaped holes.

FIG. 3.
MINIMUM COMPRESSED O.D. – Less than ½" greater than coupling O.D. – providing ample running-in clearance.

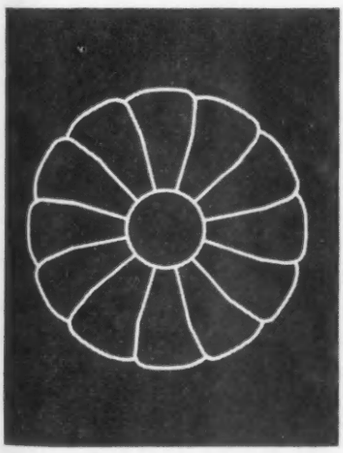
FIG. 4.
MAXIMUM EXPANSION – The Basket expands to more than twice the diameter of the casing on which it is run in sizes 5½" and larger.



When running in the hole, the metal petals readily compress as the fluid exerts upward pressure. Normal speed of running-in is maintained, and excessive friction of the Basket assembly against the I.D. of the casing, or the open hole, is avoided.

When the casing comes to rest, the Basket expands against the wall of the hole. Further downward passage of fluid is effectively minimized, until...

The solids strained out of the fluid build up a solid bridge inside the Basket, which then serves as a strong, safe, one-way packer.



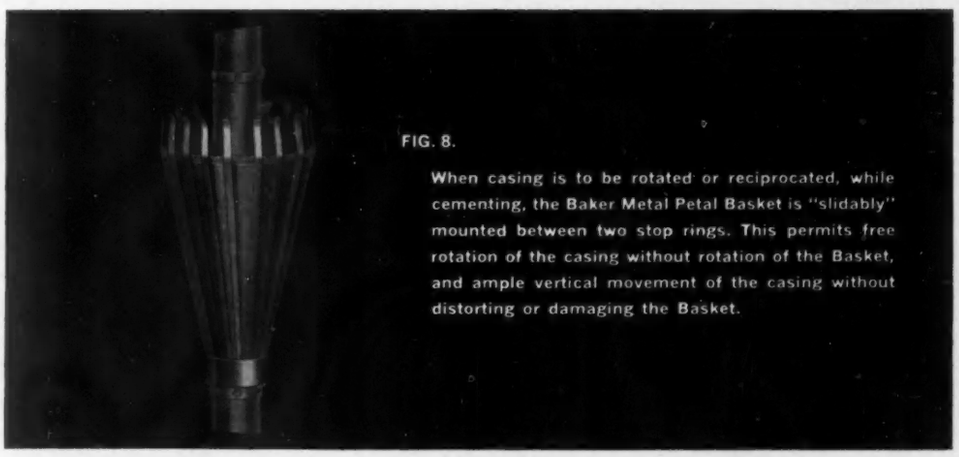


FIG. 8.

When casing is to be rotated or reciprocated, while cementing, the Baker Metal Petal Basket is "slidably" mounted between two stop rings. This permits free rotation of the casing without rotation of the Basket, and ample vertical movement of the casing without distorting or damaging the Basket.

Mountings Meet All Needs—The Baker Metal Petal Basket is furnished as a separate unit for installation to meet any requirement. Generally it is *slidably* mounted by spacing two split stop rings some distance apart to allow free travel of the Basket and free rotation of the casing. Baskets can be furnished affixed to either a *plain* or a *perforated* nipple to meet cementing requirements.

Baker Metal Petal Baskets are used extensively in combination with Baker Stage Collars to retain and support the cement slurry for the second stage. Baker Casing Centralizers are normally used above and below such combinations to provide uniform annular clearance.

Any Baker representative will give specific recommendations for the use of Baker Metal Petal Baskets; or see the BAKER (or Composite) Catalog.

BAKER

METAL PETAL BASKET

PRODUCT NO. 343

BAKER OIL TOOLS, INC.

HOUSTON • LOS ANGELES • NEW YORK

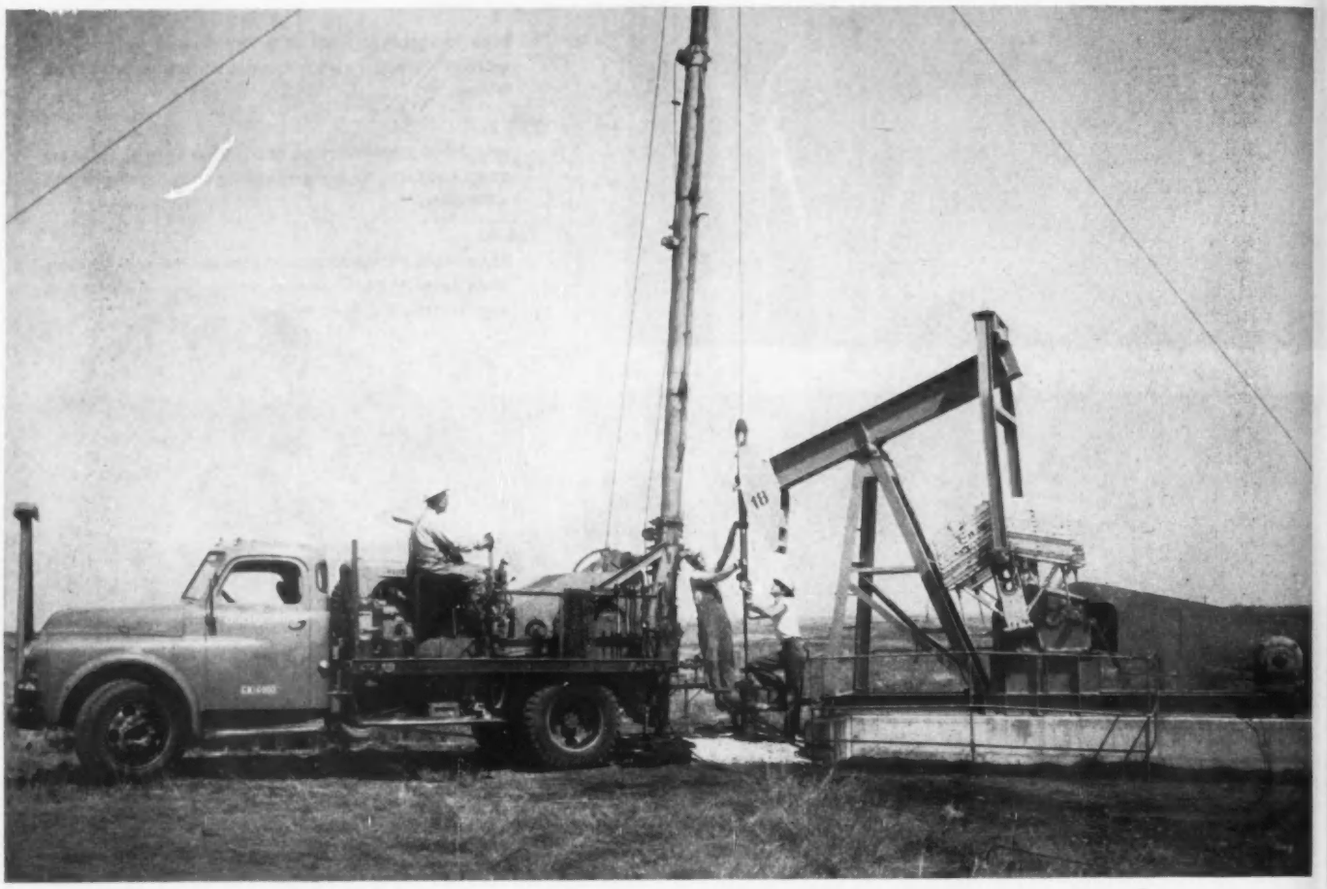


FIGURE 7—Individual pumping units on the Madison project are driven by electric motors, which have replaced the old central powers. Emulsion problems have not been serious.

works best with economical results is the type used. Since maximum recovery in a water-flood is obtained by keeping each well pumping with a minimum fluid head at all times, the wells are observed closely and changes in bottom hole equipment are made as necessary. In high volume wells some tubing type pumps are in use. In others, rod insert pumps and common working barrels and valves are in use.

Emulsion problems have not been serious. Gas injection had no adverse effects on the oil in place in the formation. The high gravity of the crude (40 API) has been an important factor. In order to handle the large volumes of water produced and obtain good separation of oil and water so that the produced water going to the water plant would be oil free, 8 x 22 feet free water knock outs have been installed ahead of the 12 x 18 feet gunbarrels on the three major units. Emulsion breakers are used only in the winter time and then with a ratio of 1300 barrels of oil per gallon of emulsion breaker. No heat is used at any of the tank batteries. Accumulation of tank bottoms is not serious and is due mainly to paraffin.

Corrosion is a major problem in both the input system and the producing system. Anodes have been installed in the free water knockouts and the gunbarrels with good results. Most of the producing wells are being treated with either a corrosion inhibitor or a scale preventer or a combination of both. This treatment has reduced well pulling costs considerably. During the summer and fall of 1956, the water treating system was worked over and is now providing a very good quality of water. With this water, corrosion in the input system will be reduced. The characteristics of the injection water are as follows:

pH	7.5
Fe	Less than .5 ppm
Hydrogen sulfide	0
Supersaturation of $CaCO_3$	Less than 10 ppm
Turbidity	Very low

Scale preventatives are being used on several wells with good success. Scale troubles seem to appear on some wells and not on others. It is believed that scale will increase in the future.

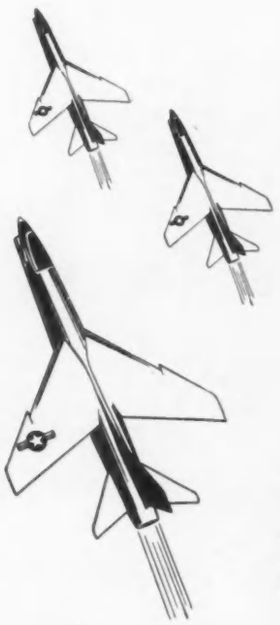
Well testing is another important phase of any water-flood. Each major unit has a well checker located at the battery so that the wells may be checked by the pumper with a minimum amount of time. For edge wells that are not on individual lead lines to the tank battery, a trailer mounted well checker is used. Good evaluation of flood results is obtained by frequent and regular testing.

ACKNOWLEDGMENT

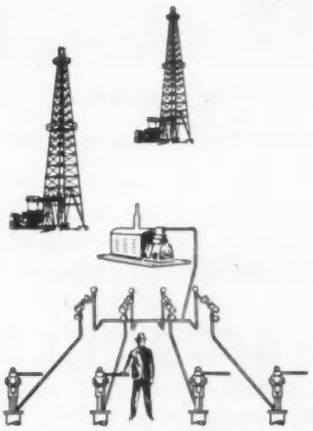
The authors wish to thank Cities Service Oil Company for willingness to give the information contained herein for publication. They are grateful to George F. Berry and William P. Fleck, Geological department, Cities Service Oil Company, for their geological description and to James R. Thoma, production engineer, Cities Service Oil Company, for his drawings and curves used in the article.

SARGENT

SYSTEMS OF FORCE CONTROL



OIL WELL CONVENTIONAL AND HYDRAULIC PUMPING SYSTEMS



mean BETTER deep well pumps for you..

For 37 years Sargent Engineering Corporation has been producing oil well pumps and precision equipment to meet Army, Navy, Air Force and commercial requirements.

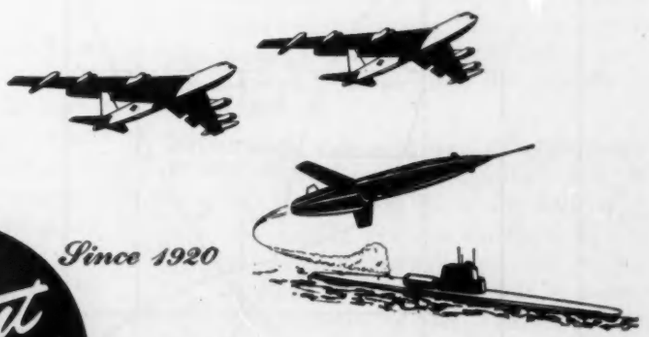
The metallurgical, mechanical, hydraulic and pneumatic knowledge gained in the development and production of these advanced and highly classified military components has been incorporated where possible by Sargent to build a better pump—the "Sargent Pump"—the heart of oil production.

Sargent builds every A.P.I. classified pump and pump parts plus a highly efficient long-stroking rodless bottom hole hydraulic pumping system. Through research, superior engineering, design and metals, Sargent builds bottom hole pumps to meet all deep oilwell pumping conditions.

You gain by using Sargent's superior quality which has been the Standard of Excellence since 1920, at competitive prices to meet and supply your pump needs.

Sargent pumps, both conventional or hydraulic, can be completely serviced in the field or by company trained experts in Sargent operated field stores.

"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
— U.S. Supreme Court



Standard of Excellence *Since 1920*

SALES AND SERVICE

CALIFORNIA	OKLAHOMA	TEXAS	ILLINOIS
Long Beach	Oklahoma City*	Odessa	Grayville
Bakersfield	Ratliff City	Snyder	ARKANSAS
Santa Maria	Pawhuska	Andrews	Magnolia
Ventura	Seminole	Houston*	KANSAS
Taft	NEW MEXICO	Midland*	Chase
Huntington Park	Farmington	Sundown	Russell
Santa Fe Springs	Hobbs	Wichita Falls	Great Bend*
	COLORADO	Quitman	
	Rangely		

*Sales Representation

Sargent — QUALITY BUILDS GOOD WILL

ENGINEERING CORPORATION

MAIN OFFICE & PLANT • 2533 E. FIFTY-SIXTH ST.
HUNTINGTON PARK, CALIF.

For Your PRODUCTION File

Part 2 in a series on reservoir engineering

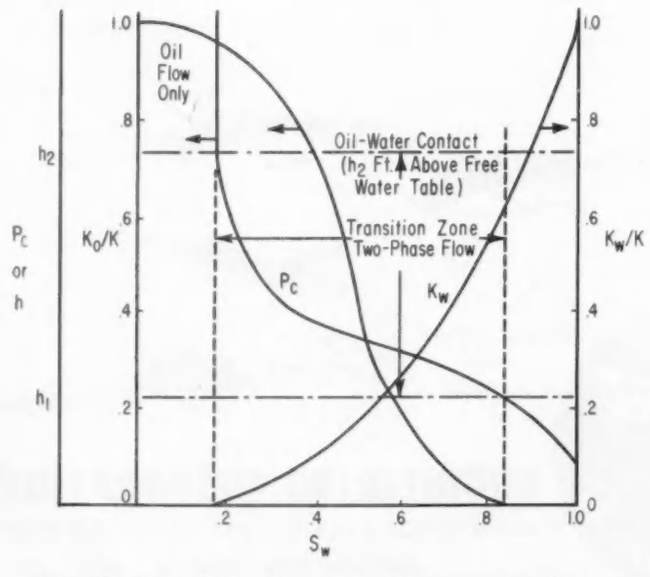
Significance of the Oil-Water Contact

The oil-water contact is significant in calculating reserves, selecting well-completion intervals and making reservoir engineering studies.

By Frank W. Cole,
Assistant Professor Petroleum Engineering
School of Petroleum Engineering, University of Oklahoma, Norman, Okla.

IN ALL OIL reservoirs where a water table exists, those concerned with the operation of the reservoir will sooner or later use the term "oil-water contact." Although it is well understood that, due to capillary forces present in the reservoir, there will be no sharp line of demarcation between the water zone and the oil zone, very little published information is available concerning an exact definition of the term "oil-water contact." This is a very important term when:

- Oil reserves are being calculated.
- Well-completion intervals are being selected.
- Reservoir enginering studies are being made.



Relative Permeability Curves, Capillary Pressure Curve.

Most oil companies have their own standard definition of oil-water contact; however the exact meaning of this term may vary from company to company. A definition which many engineers use and which is considered by the author to have the most merit of any definitions he has seen used is as follows: The oil-water contact is defined as the lowest structural position in the reservoir from which 100 percent oil can be produced.

This lowest point in the reservoir from which 100 percent oil can be produced will be a function of relative permeability and capillary pressure. Figure 1 shows a plot of relative permeability and capillary pressure data plotted on the same ordinate for a hypothetical water-wet system. Therefore, from Figure 1 the oil-water contact, as defined above, would be at h_2; since according to the relative permeability data, this would be the point of minimum water saturation, or no additional water flow. This point corresponds to the minimum, or interstitial water saturation on the capillary pressure curve. As shown on Figure 1, both oil and water would be flowing between h_1 and h_2. The thickness of this transition zone may vary from only a few feet to several feet, depending upon the wetting characteristics and the pore configuration of the reservoir rock.

Substantial oil can possibly be produced below the oil-water contact, depending on the thickness of the transition zone. This could very possibly have an economic bearing on reserve estimations where the transition zone is relatively thick.

TO BE CONTINUED

International Section

This Upper Cretaceous reef buildup has drawn interest in Cuba's Camaguey province. Formation is topped by 15 to 20 feet of massive limestone. Beneath the thick coquina-like detrital limestone about 50 feet of the buildup is exposed and up to 200 or 300 feet is hidden by alluvium.

Drilling and Exploration To Increase in Cuba

Oil operations unaffected by recent revolutionary activity on the island.

IMPORTANT PROGRESS in oil development operations in Cuba is in prospect. Several large companies are planning to drill tests on their acreage holdings. Considerable exploratory work will be done by major companies. Companies which have completed enough exploratory work to convert their acreage holdings into concessions are negotiating with other firms to have wells drilled on farmouts.

Cuban Stanolind Oil Company, which is committed to spend $10 million or more in exploratory work on the island within five years in order to obtain a one-half interest in concessions covering a total of 16 million acres, will drill a well in waters off the south central shore of Cuba. This will be the first well ever drilled in waters off the southern coast of Cuba. The offshore drilling is believed to have been prompted by geological information obtained by Cuban Stanolind from two wells drilled inland in Oriente Province.

Cuban Stanolind has completed construction of a coral island several miles off the south shore of Camaguey Province on which it will drill a test. The water at that point is not much more than six feet deep. Cuban Stanolind now is completing construction of piers and other wharf facilities, and a bridge will connect the island to shore. Location of the island is due south of the Jatibonico oil field of the province.

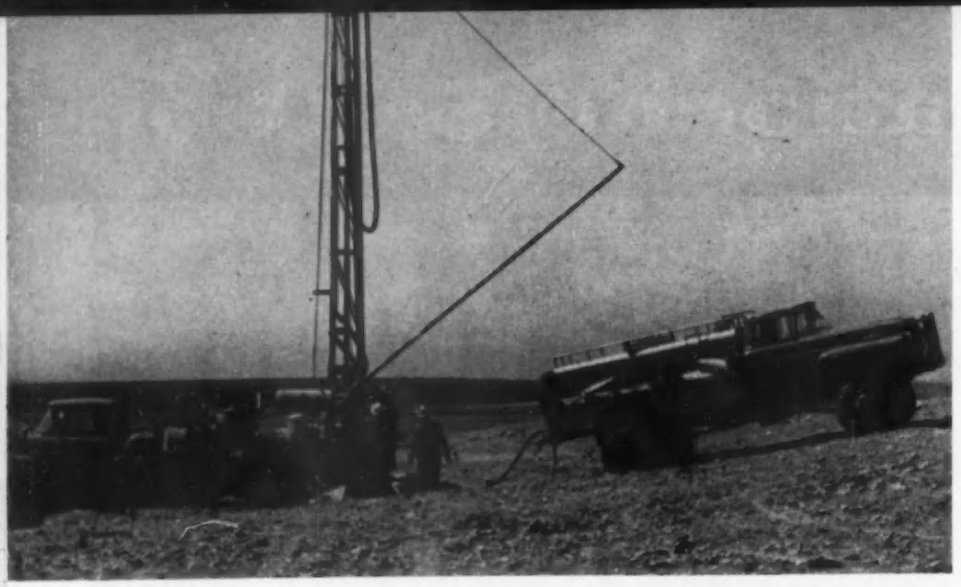
The recent revolutionary activity in Cuba did not bother or particularly interest oil men. They say the government is friendly to the petroleum industry and that, regardless of who may be in power, oil men will be encouraged to continue their activities and will have the protection and support of the government.

Oil development is too important to Cuba to be handicapped in any way and all factions—governmental and citizen—realize this, according to persons conversant with Cuban governmental affairs and the attitude of the public.

Cuban Consolidated Oil Company completed recently another well in the Bacuranao-Cruz Verde field, near Havana, in Havana Province. It was reported to have flowed 600 barrels of oil in two days, according to an announcement of Dr. Alberto Diaz Masvidal, a director of the company. However, he warned against undue optimism about future production of the well. He said it would have to be produced for several weeks before it would be possible to make any kind

Continued on Page 184

Need for New Oil Spurs Exploration In Israel



This portable rig is drilling shot holes for seismic studies in Israel's Negev desert.

Seismic operations in the Negev desert indicate that speeded up program will pay off.

After the shot hole is drilled, explosives are unloaded from the "shooter" truck and . . .

Exploration parties are operating at an accelerated pace in Israel currently, paralleling increased drilling, producing and pipe line operations. This continuing high level of industry activity stems largely from the status of Heletz oil field, a 1955 discovery which was developed thoroughly by mid-1957 with 18 wells on production as of August 31, and the discovery in June of 1957 at Burr, immediately south of Heletz field, where three wells were capable of production.

The tempo of Israel's exploration operations is indicated by these photos of seismic operations in the Negev desert's Lachish license being conducted by Pan-Israel Oil Company and Israel Mediterranean Petroleum, Inc.

. . . Detonator cap and rubber shield are attached before . . .

. . . Explosives dropped into the hole.

What's Happening among WORLD OIL MEN

Dr. Jose Antonio Giacopini Zarraga

Dr. Cesar Miguel Rosales W.

COMPANIA SHELL DE VENEZUELA LTD. has announced the promotion of three executives to new posts. DR. JOSE ANTONIO GIACOPINI ZARRAGA, former head of public relations, has been named assistant to the president of Compania Shell. DR. RAFAEL MORELLO C. was appointed manager of general affairs. Until recently, he had been field superintendent. The new head of public relations is DR. CESAR MIGUEL ROSALES W., who had been assistant superintendent in the La Concepcion district until this year.

Dr. Rafael Morello C.

•

THE BRITISH AMERICAN OIL COMPANY LIMITED, Production and Pipe Line department, Calgary, announced the appointment of F. D. AARING, as zone manager of the Calgary Production zone. Aaring assumes the position vacated by K. H. GIBSON. In 1948, Aaring joined Gulf Oil Corporation at Seminole, Okla. In March, 1957, he was appointed chief petroleum engineer, Production department, Calgary. In his new position Aaring will be responsible for production operations in northern and central Alberta, British Columbia and the northwest territories.

RICHARD L. HUGHES will manage the new Canadian offices of V. ZAY SMITH ASSOCIATES in Calgary, Alberta. He was formerly an administrative geologist with Geophoto Services, Ltd., and has actively engaged in photogeologic evaluations throughout Canada for the past five years.

•

SUNRAY OIL CO. of Oklahoma, wholly-owned subsidiary of Sunray Mid-Continent Oil Co., will establish an Exploration division in Canada to intensify the company's search for oil in the Western provinces. KARL F. MARTIN, JR., has been named Canadian division exploration manager for Sunray and will be in charge of new offices being established in the Petroleum building in Calgary. Martin joined Sunray in 1948 as landman in the company's Midland, Texas, office.

FRED G. PHELPS, research geologist for Sunray, has been named chief geologist for Sunray's Canadian division. He worked for Sunray as a geologist from 1936 to 1947, then was engaged in independent geological consultation until 1955 at which time he rejoined Sunray as research geologist. PAUL T. BAUMAN, geologist for Sunray, will be transferred to Calgary in the same capacity. He joined Sunray in 1954. COLEMAN B. FITE was employed by Sunray in 1953. He has been geologist in the company's Jackson, Miss., San Antonio, Texas, and Lafayette, La., offices. He will be assigned to the Canadian division.

•

MOBIL OIL OF CANADA, LTD., announced the election of two western Canadians as officers of the company. B. E. TAYLOR, comptroller and director, was elected a vice president and company treasurer. JOSEPH SPIVAK has been promoted to exploration manager and elected a director. Taylor joined Mobil Oil of Canada in 1946. Dr. Spivak's early career was spent as a geologist in the gold mining areas of Manitoba. After joining Mobil Oil as a geologist in 1944, he became chief geologist in 1951, and in 1953 assumed the additional duties of assistant manager of exploration.

•

ROBERT E. KEPKE has been appointed president and chief executive officer of the BRITISH-AMERICAN OIL PRODUCING COMPANY and its affiliate, the TORONTO PIPE LINE COMPANY. For the past four years Kepke has served as executive vice president of both companies, whose headquarters are in Dallas. Kepke's career with the British-American organization began in 1941 as the company's legal counsel in Texas. Thereafter, in turn, he was appointed assistant to the executive vice president of the American companies, and a vice president and director of the British American Oil Company Limited in Canada, before his appointment in 1953 as executive vice president of the British-American Oil Producing Company and the Toronto Pipe Line Company.

Robert E. Kepke

•

KELLY H. GIBSON was appointed vice president for production of PACIFIC PETROLEUMS LTD. Gibson will be responsible for all drilling and production operations of Pacific Petroleums.

He has been associated with development of the Canadian petroleum industry since 1949, when he came to this country as area production manager for Canadian Gulf Oil Co. at Stettler, Alberta. He was appointed Calgary zone production manager when the British American Oil Co. acquired the Gulf interests in Canada, and since that time has been responsible for British American's drilling and production operations for central and northern Alberta, British Columbia and the Northwest territories. Gibson joined the Gulf Oil Corporation in Kansas in 1936.

a WORLD of OIL

ALGERIA: Reports from Algiers indicate work has commenced on a 120-mile crude oil pipe line from Hassi Messaoud to the rail head at Touggourt. The line was to be built by the French government. Diameter is ten-inch or larger, and completion was expected by the end of 1957. Throughput was expected to average 10,000 barrels daily in 1958 and 16,000 barrels per day in 1959.

ARGENTINA: Fuel purchases for 1957 were expected to amount to $367 million, exceeding the previous year's figure by $117 million, according to *Noticias*. Bill for imported fuels and lubricants during first half of 1957 was $200 million, representing over one-fourth of total foreign exchange expended for imports . . . Argentina and Bolivia reached an accord by which oil and gas fields straddling the border will be developed jointly by the two governments.

AUSTRIA: Austrian Mineral Oil Administration (AMOA) plans to build a new 47,000 barrels per day refinery at Schwechat, near Vienna. Completion is planned for 1961. A West German engineering firm was being retained to draw up formal plans.

BRAZIL: Petrobras reports an important oil strike in Jequia, Alagoas, producing at the rate of 250 barrels daily. Extensive tests were planned . . . Chemische Werke Huels, operator of a monostyrene plant at Cubatao, was reported to be planning to expand output. C. Verolome Dock and Shipyard (The Netherlands) was building four 33,000-ton tankers for Petrobras.

CHILE: Under new legislation revised by the Chamber of Deputies' Mining Committee, Empresa Nacional de Petroleos (ENAP) would be permitted to grant subconcessions to foreign investors to obtain additional capital for oil operations.

CUBA: Atlantic Refining Company was to spud a wildcat during the fall of 1957 located 60 miles southwest of Havana near Los Palacios. Projected depth was 9000 feet.

FRANCE: Societe des Petroles de Valence was preparing to drill its first test in the Luberon area north of Marseilles. Two previous tests, both dry holes, have been completed by the company in the Valence basin, and a third test was being drilled. Near St. Julien-en-Born on the southwest coast of France, a new exploration permit was granted late in 1957 covering 27,300 hectares.

GUATEMALA: Between $20 million and $30 million is expected to be spent in Guatemala during 1958 for exploration on 39 exploratory permits covering 3,785,324 hectares granted by August 1957. As of mid-October 1957, there were 103 concession applications on file and under consideration in Guatemala. Story J. Sloane had drilled the first test in Izabel Province. Ohio Oil Company planned to drill in Peten Province, near the Mexican border, early in 1958, according to *Noticias*.

IRAN: National Iranian Oil Company was reported drilling two wells in September, 1957, in the Qum vicinity, Alborz 6 was drilling below 9850 feet, with oil shows reported at about 8750 feet; along the south shore of the Caspian Sea near Mahmudabad, a second test was reported drilling at 3870 feet, after the first was suspended at 3940 feet. A second rig was to be brought into the Qum area, and a rig was to be assigned to drilling at Nafti-Shah on the Iraq border . . . Daily average crude oil production in South Iran was 766,000 barrels per day during September, 1957. At the Abadan Refinery, throughput was 325,000 barrels per average day during the same month.

MEXICO: PEMEX believes that the Reynosa-Monterrey gas pipe line will be completed this year. About half the 250 kilometres (155 miles) line was finished on November 9, PEMEX officials reported. The 56-centimetre line will carry more than 10 million cubic metres of gas daily from the Reynosa field, chiefly to supply Monterrey . . . In order to improve distribution in the State of Mexico, PEMEX is laying an oil pipe line from the Azcapotzalco refinery, Mexico City, to the state capital, Toluca. In Toluca, a tank storage farm is nearing completion. PEMEX reports that the whole project will be finished by mid-1958. The pipe line will carry gasoline, diesel oil and tractoline.

NEUTRAL ZONE: Crude oil production was nearing 100,000 barrels per day at the end of September, 1957. Five rigs were in operation toward the end of the year.

NICARAGUA: Legislation has been introduced to the Chamber of Deputies governing exploitation of oil.

PARAGUAY: Gulf Oil Corporation was negotiating for exploration concessions in Paraguay in late 1957.

PUERTO RICO: Commonwealth Oil Refining Company recently appropriated funds to allow expansion of Ponce Refinery capacity from 58,800 barrels per day to 75,000.

RED CHINA: The Chinese claim to have completed construction of a refinery in the desolate Tsaidam Basin to process crude oil discovered and produced there within the past two years.

SAUDI ARABIA: Arabian American Oil Company has been put in an unusual squeeze by politicians in both the U. S. and Saudi Arabia. Wyoming Democrat Senator Joseph O'Mahoney wants Aramco's depletion provision deduction reduced or eliminated, thus allowing U. S. Treasury to benefit directly from Aramaco's oil and gas production in Saudi Arabia. Shaikh Abdullah Tariki wants to find a way for the Saudi Arabian treasury to profit directly from marketing operations of Saudi Arabian oil in foreign countries, including the U. S.

SUMATRA: Standard-Vacuum Oil Company has completed the first catalytic cracking unit to be built in Southeast Asia at the Sungei Gerong Refinery near Palembang, Sumatra. The $8 million plant will allow production of 6140 barrels per day of

high-quality anti-knock gasoline components by fluid cat cracking of Sumatra crude. Included in a general $31 million refinery expansion program are, in addition a reformer stabilizer, a catalytic polymerization plant, a sulphuric acid manufacturing unit. Two 3000-hp gas turbines are installed in the new cat cracker, fueled by refinery gas. Foster Wheeler was the contractor. Raymond Concrete Pile Company provided foundations for the cat cracker and other Sungei Gerong process units.

TURKEY: Deutsche Erdoel was granted exploration concessions by the Turkish government in eight areas, reportedly aggregating over 900,000 acres. Five of the areas are contiguous and located near the Syrian border. The other three are in southeastern Turkey in the general region of Raman and Garzan oil fields. Amoseas spudded its second well in Turkey in late November, 1957, following abandonment of Aril 1 at 10,153 feet earlier in the year. American Overseas Petroleum Ltd. Kahta 1, the new well, is located on a structure 17 miles southeast of Adiyaman, 70 miles northeast of Aril 1.

VENEZUELA: A new $84 million deepwater oil terminal will be built by Shell in Venezuela, at Punta Gorda in the Maracaibo area. Slated for late 1959 completion, the terminal is planned for a capacity of 700,000 barrels per day. Storage facilities are to allow 4 million barrels capacity . . . Creole Petroleum Corporation has completed a new 104,000 barrels per day distillation unit at Amuay Refinery. The fourth distillation unit to be built at Amuay, the newest one raises capacity to 328,000 barrels daily. Creole continues to refine an increasing portion of its crude within Venezuela. Bachaquero field crude will be run in the new unit, for light naphtha and fuel oil. Foster Wheeler Corporation of New York City were constructors for the new distillation plant . . . Paria Operations Inc. is a new firm organized by five oil companies to operate the 152,000-acre offshore concession granted earlier in 1957 by the Venezuelan government. Four drilling platforms were being constructed, and drilling operations were expected to commence by mid-October. The five companies are Continental Oil Company, The Ohio Oil Company and The Texas Company, each with a one-quarter interest in Paria Operations; Cities Service Company, 16-2/3 percent; and Richfield Oil Corporations, 8-1/3 percent.

WEST GERMANY: Getty Oil Gesellschaft is a recently-founded German subsidiary of Getty Oil Company, set up to build a refinery in the lower Rhine River region. The company was reported negotiating with officials of the town of Rees for property and permits that would establish the site. The new plant would process Middle East crude and produce fuel oil primarily . . . Migrol, affiliated with Swiss interests, will reportedly build a 30,000 barrels per day refinery at Emden, West Germany. Ralph M. Parsons Company of Los Angeles is said to be the contractor. The new plant will cost $17.5 million, is scheduled to go on stream during the fall of 1959, and will run Neutral Zone crude produced by American Independent Oil Company. Products anticipated are fuel oil (60 percent of total), distillates, diesel oil, gasoline and LPG. Eventual capacity may reach 60,000 barrels per day.

YEMEN: The Yemen Development Corporation secured a concession on oil and other minerals covering an area of about 40,000 square miles in Yemen. Oil and Gas property management of Dallas owns a 50 percent interest in the Yemen Development Corporation. A party of surface geologists is currently in Yemen.

Expansion of Capacity of Tapline Is Progressing

Trans-Arabian Pipe Line Company continued its program for expansion of Tapline's capacity on schedule. Auxiliary pumping units entered operation at Uwaigilah and Turaif in October 1957. The 5000 horsepower centrifugal pumps installed at Shubah and Jalamid went on stream in late September. Uwaigilah is located between Badanah and Rafha; Shubah, between Qaisumah and Rafha; and Jalamid, between Turaif and Badanah.

Construction of the Turaif gas turbine pump house was well advanced by late October, with the control unit having been set up on foundation. A new 180,000 barrel tank at Rafha was scheduled for oil-testing in October. New radio towers had been erected at Badanah, Turaif and Km. 1013, with the Jalamid tower nearing completion. Installation of radio towers at Uwaigilah, Rafha, Shubah, Qaisumah and south Lebanon was expected to be completed by Dec. 1, 1957.

A 5000-hp turbine at Wariah in the Aramco part of the Trans-Arabian pipe line system has been in operation since February, 1957.

Trans-Arabian Pipe Line Company has announced a new all-time record for deliveries of crude oil at Sidon, Lebanon. During October, 1957, a total of 12,225,368 barrels, or an average of 394,367 barrels per day, was delivered from Sidon. Previous record was set during May, 1957 (380,038 barrels daily).

During the first ten months of 1957, Tapline delivered an average of 344,390 barrels per calendar day for a total of 104,694,610 barrels. Despite the tanker shortage early in 1957, the 1957 figure exceeds the amount delivered during the first ten months of 1956, when 100,834,580 barrels were delivered for an average of 330,605 barrels per calendar day.

Saudi Arabian Production Off for First Ten Months

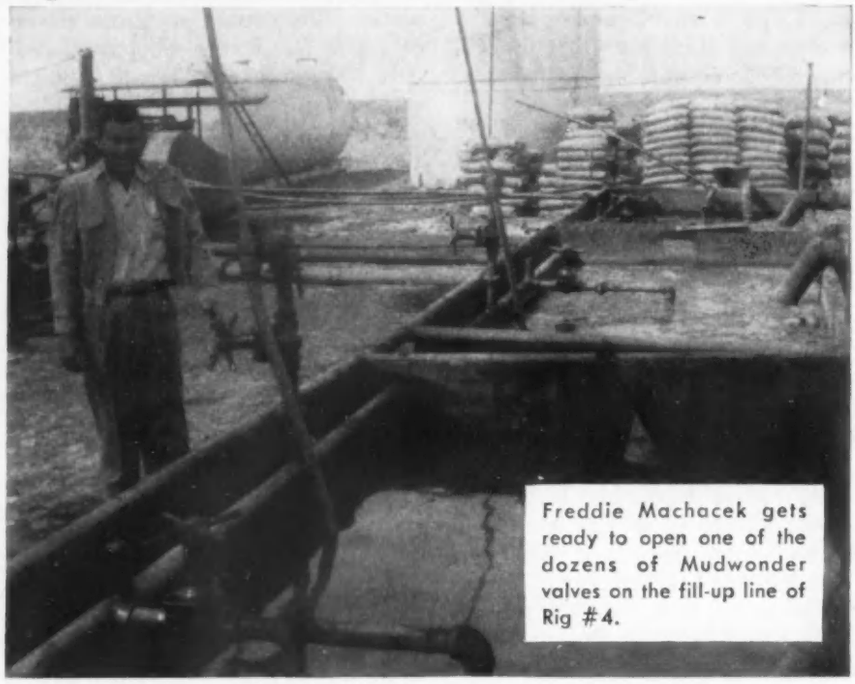
Crude oil production in Saudi Arabia during October totaled 32,385,747 barrels, or an average of 1,044,702 barrels per calendar day, the Arabian American Oil Company announced. This compares with 32,701,704 barrels, of an average of 1,054,894 barrels per calendar day, during the same month last year.

Crude processed at Aramco's Ras Tanura refinery during October amounted to 5,628,966 barrels, an average of 181,580 barrels per calendar day, as compared with 5,634,810 barrels, an average of 181,768 barrels per calendar day, during the same month last year.

Aramco's total production of crude oil during the first ten months of 1957 was 299,055,856 barrels, an average of 983,736 barrels per calendar day. This compares with a total of 317,930,475 barrels, an average of 1,042,395 barrels per calendar day, during the same period last year.

Crude run in the refinery during the first ten months of 1957 amounted to 59,805,530 barrels, an average of 196,729 barrels per calendar day, as compared with 62,290,037 barrels, an average of 204,230 barrels per calendar day, during the same period last year.

Tips on Mud Valves for Toolpushers . .



Freddie Machacek gets ready to open one of the dozens of Mudwonder valves on the fill-up line of Rig #4.

MUDWONDER Ideal for Versatile Service

by Freddie Machacek, Toolpusher, Rig #4
B.B.M. Drilling Company, Midland, Texas

ABOUT two years ago I put a *Mudwonder* valve on our fill-up line just to see how it would make out. I soon found that *Mudwonder* worked fast and easily, without binding, even while bleeding off the line at 1600 lbs pressure. It did so well I tried more *Mudwonders* on the tough job of mud pit service—and they were so successful I've standardized on *Mudwonder* ever since!

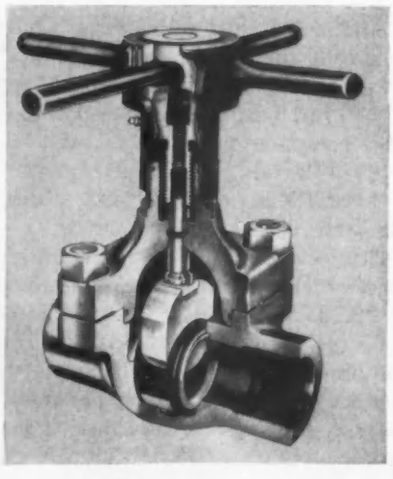
Valves on mud guns and jets take a terrific beating, but we've had very little trouble with *Mudwonders.* As a matter of fact, our first ones are still in service; we replaced the stem packing on one valve—that's all! Because replacement parts are so easy to identify, we never have any trouble getting the exact part we need. In fact, the valves are designed to use the same seat and gate for both pressure classes.

When we have to dress a *Mudwonder,* the job can be done without disturbing any connections. The valve is out of service only about 10 minutes, start to finish, regardless of size. Another thing—they never sand up. Bob Lawrence, Edward *Mudwonder* Representative, says this is because the design causes the mud to flush the bonnet automatically.

Mudwonder valves are available in 2", 3" and 4" sizes; with screwed or flanged ends; rated at 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test). See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana, subsidiary of Rockwell Manufacturing Company.

(Adv.)

Mudwonder cut-away view shows the one-piece seat insert, with Buna-N molded integrally over steel wear rings; chromed gate with "T" slot connection; separated stainless stem and double thread construction.



Pure Oil et al Complete Good Well in Venezuela

A new Lake Maracaibo discovery is good for 2400 barrels per day. Pure Oil Company, Standard Oil Company (Ohio), Hancock Oil Company, and Signal Oil and Gas Company reported 40-gravity crude oil flowing from 12,113-12,183 feet through 5/8-inch choke in a wildcat seven miles from production, in the center of a 28,000-acre concession granted in 1956.

The pay zone is in sand 70 feet thick. Additional oil sands aggregating 350 feet in thickness were found at shallower depths. The Pure-Standard-Hancock-Signal group's first well in Lake Maracaibo, suspended during the summer of 1957, was to be deepened.

Gas Line and Plastics Plant Planned for Iran

Development and Resources Corporation plans to carry out construction of the following projects in Iran:

1. A natural gas pipe line from Agha Jari oil field 70 miles to Ahwaz to provide the raw material for future petrochemical plants there, including:

2. A polyvinyl chloride plastics plant at Ahwaz, which will utilize casinghead gas now being flared in the South Iran fields located north and northeast of Abadan.

David E. Lilienthal is chairman of the board of Development and Resources Corporation, and Gordon R. Clapp is president. Headquarters of the new firm are at 50 Broadway, New York City.

Outlook in Cuba

Continued from Page 179

of an accurate estimate of what it was good for.

Cuban Consolidated is the company that previously completed a well in the Cruz Verde oil field, flowing at a rate of 520 barrels of oil a day, without showing, then, any indications of a decline.

Cuban American Oil Company has completed its Catalina 3, one-half mile southwest of its Catalina 2, just south of the Jatibonico oil field in Camaguey Province. It was reported making 25 barrels of oil and from 6 to 10 barrels of water a day. Catalina 1 still is producing about 35 barrels of oil a day. Well 2 has good showings of oil, but the operator had not set

pipe to make a good production test.

Shell Oil Company has started drilling Manuy 1, two to three miles off the north shore of Camaguey Province, on acreage held jointly with Atlantic Refining Company and Standard Oil Company (New Jersey). The well is being drilled from an offshore barge owned and operated by C. G. Glasscock. It was reported at 1200 feet, although it is a "tight" hole. It is designed for a 15,000-foot test.

Siboney-Caribbean Petroleum Company of Tulsa has extensive holdings in Cuba which have been surveyed by the government, resulting in a 3,838,192-acreage position for the Tulsa firm. This acreage can be converted into concession form at any time.

Siboney-Caribbean is the first company with holdings of this size to have them surveyed completely by the government. The company plans to continue its exploratory program in order to further detail prospective areas. In addition, plans were being made to drill the prospects developed to date. The company also was considering several farmout drilling proposals it had received.

Kewanee Oil Company, Tulsa, has started drilling its Collazo 1 in the northwest corner of Camaguey Province, not far from the offshore test of Shell Oil Company which is being drilled in shallow water. It was reported drilling below 6000 feet, and is designed to go to about 12,000 feet. This test is near the north coast of the province.

Cavalier Petroleum Company of Tulsa, jointly owned by Russell Cobb, Jr., Inc., and the Benedum interests of Pittsburgh, have plans for further exploratory work and drilling of their concession in Oriente province in the southeast corner of the island.

Actual drilling activity in Cuba now is at a minimum because this is the interim period between assembling of acreage and the development of that acreage.

The promotion period, during which companies and individuals sought to get acreage allotted to them, is past. The government has allotted practically every acre of prospective oil producing territory on the island and surrounding waters. The area on land, without counting the shallow waters covered by concessions, constitutes 23.3 million acres. The island is approximately 730 miles long with an average width of about 50 miles.

Companies which got in on the ground floor in Cuba, such as Trans-Cuba Oil Company, Cuban-Venezuelan Oil Voting Trust, Cuban-American Oil Company and others, long ago had completed necessary steps to have their acreage converted into concessions. They are in positions to negotiate deals for development of their holdings, such as the agreement made by Stanolind Oil and Gas Company with Trans-Cuba Oil Company and Cuban-Venezuelan Oil Voting Trust for an interest in the holdings of these two companies.

Some major oil companies which acquired interests within the past year or so are conducting exploratory work at this time, preparatory to pinpointing their acreage for development work and conversion into concessions.

Still other companies are negotiating drilling deals on a farmout basis.

The oil situation in Cuba has been summarized by an American oil company official:

"The year 1956 marked a period of transition from adolescence to early maturity in Cuban oil exploration. From the scramble to drill wells without regard to geology, there developed a more orderly and scientific approach in the search for oil. This maturity should continue and give rise to the testing of many sound oil and gas prospects throughout the Republic."

Six producing fields have been found in Cuba thus far. Of these, five are producing from the Serpentine formation at a comparatively shallow depth. The sixth is the only field producing from sedimentary formation.

The Serpentine formation is not an original oil-bearing horizon—that is, oil contained in it was not formed there but seeped into it from some other source. Hence, search is being made for the source bed of the oil found in the five Serpentine formation oil producing fields. The Jatibonico field in central Cuba is the only field producing from the sedimentary formation. The fact oil production has been found in the Serpentine is proof of the existence of oil in commercial quantities at greater depths somewhere in the vicinity of these fields because the oil found had to seep up to and into the Serpentine.

—The End

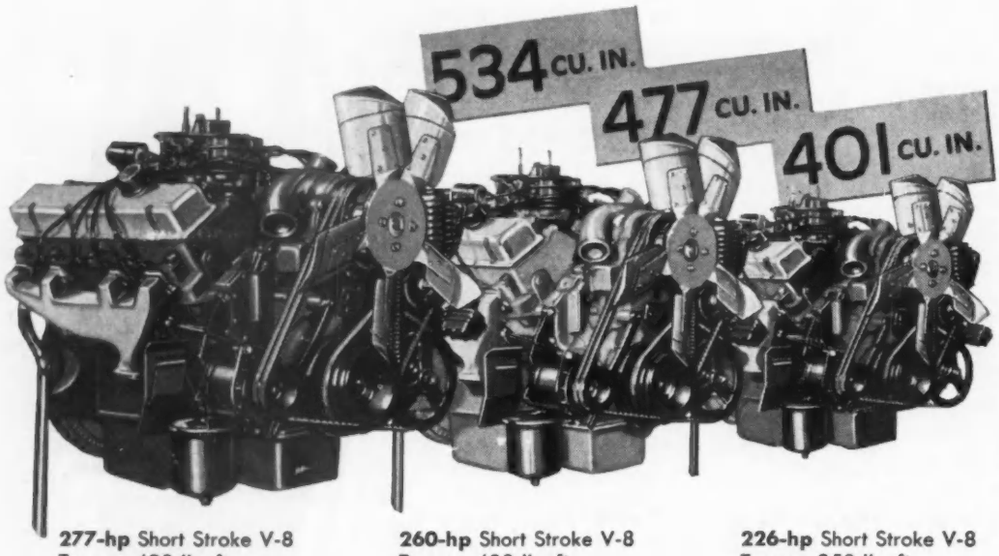
B and W Multi-Flex Scratcher
B and W Inc.
For a good cement job
B and W Automatic Stop Collar
B and W Latch-On Centralizer
Also: B and W Multi-Flex Scratcher • Hinged Nu-Coil Scratcher • Rotating Scratcher, Multi-Flex type • Rotating Scratcher, Nu-Coil type • Latch-On Centralizer with Ken-Kave Bow • Latch-On Stabilizer • Stabilock
B and W Inc.
Well Completion Specialists
GULF COAST
Box 5266
Houston 12, Texas
Phone WA 3-6603
WEST COAST
Box 3751, Terminal Annex
Los Angeles 54, California
Phone FAculty 1-2463
6908

For more data on advertised products, use Readers' Service Cards, last page.

FORD makes the

3 all-new Super Duty V-8's

- Gross horsepower up to 277
- Gross torque up to 490 lbs-ft
- Modern Short Stroke design
- Three-stage cooling system
- Machined combustion chambers
- Sodium-cooled exhaust valves
- Stress-relieved block and heads
- Pyramid-type connecting rods
- Internally mounted oil cooler
- Two-quart oil filter
- Water-jacketed intake manifold
- Submerged-type electric fuel pump



277-hp Short Stroke V-8
Torque: 490 lbs-ft
@ 1800-2300 rpm

260-hp Short Stroke V-8
Torque: 430 lbs-ft
@ 1800-2300 rpm

226-hp Short Stroke V-8
Torque: 350 lbs-ft
@ 1800-2300 rpm

10 all-new Extra Heavy Duty Series

GVW's up to 51,000 lb. For '58, ten new basic series are added to Ford's already extensive Heavy and Extra Heavy Duty line. Four new Tilt Cabs, four new Conventionals, and two new Tandem models offer GVW ratings up to 51,000 lb.

GCW's up to 75,000 lb. New T-950 Tandem is rated for 75,000-lb. GCW. Biggest single-rear-axle models are rated for 65,000-lb. GCW.

Front axle capacities up to 15,000 lb. Choice of three front axles in most new Ford Extra Heavies. Rated capacities of 9,000 lb., 11,000 lb. and 15,000 lb.

Rear axle capacities up to 29,000 lb. Wide choice of rear axles includes single-speed and two-speed, single reduction and double reduction types. Capacities range from 18,000 lb. to 29,000 lb.

Bogie axle capacities up to 38,000 lb. For '58 there are two new Extra Heavy Duty Tandem Axle models. The new T-950 Series features a tandem rear axle assembly rated for 38,000 lb. New T-850 Series offers choice of 28,000- or 34,000-lb. bogies.

New highway transmissions. Roadranger transmission is available in all ten new Ford Heavies and Extra Heavies. Up to 33% less shifting. "Short Fourth" highway transmissions also available on "F" and "C" Series. With these new transmissions, engines operate in peak horsepower range with greater fuel economy.

e big move for '58

's—up to 534 cu. in.

New Series T-950 Tandem model is biggest capacity Ford truck ever built! Rated up to 51,000-lb. GVW—75,000-lb. GCW. New 534-cu. in. Super Duty V-8 provides exceptional horsepower and torque with rugged durability.

FORD TRUCKS COST LESS

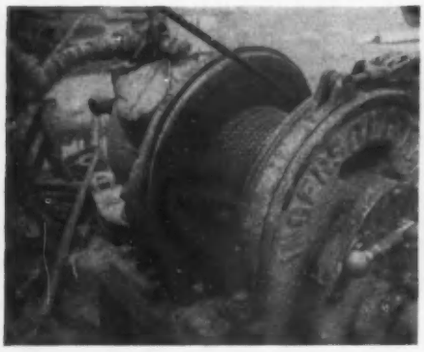
LESS TO OWN . . . LESS TO RUN . . . LAST LONGER, TOO!

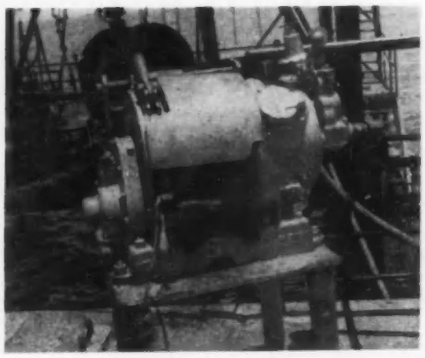
For more data on advertised products, use Readers' Service Cards, last page.

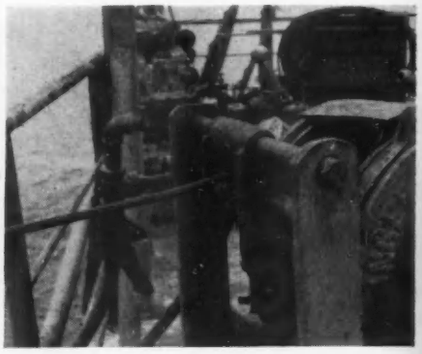
DRILLING HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.







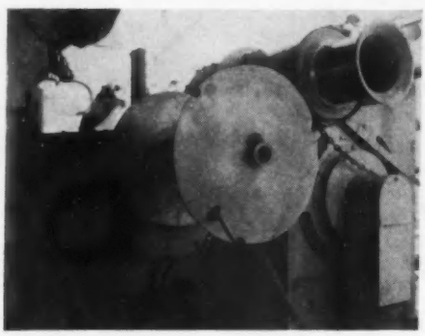
Protect Operator of Air Winch With Guard of Scrap Material

The air hoist used on the rig for pulling drill pipe casing on to the rig floor can be dangerous if there is not some means of protecting the operator. The winch pictured in the picture at the left almost cost a man his hand because he tried to guide the line onto the spool, and his hand became entangled in the winch line causing severe injury. The type of guard used on the hoist by one contractor to help the operator stay out of the line is shown in the middle picture. This type of guard will only keep the operator out of the line; it will not guide the line onto the drum.

The picture at the far right shows how a guide was attached to the winch to keep the line going onto the spool smoothly and at the same time the guide acts as a further guard for the winch line and reel. The materials used for construction are scrap plate and rod and short pieces of small diameter pipe. In construction the top cover guard is cut to fit the upper portion of the reel with openings or cut outs to clear the brake handle and other parts that must be free for operation. It is then shaped to fit the curvature of the winch frame and spool.

This cover must clear the spool so that it will not interfere with its rotation. The cover is attached to the frame of the winch by means of the bolts that hold the gear box cover. The line guide is mounted on heavier plate and is attached to the base of the winch. The arms that hold the slide bar of the guide are bolted to the winch by the winch anchor bolts or welded to the mount. The guide is made from two pieces of small diameter pipe welded about an inch apart by means of scrap plate (far right). This forms an eye for the winch line to go through.

The pipes act as slides on iron rods welded between the two mounting arms. This gives a free sliding guide, and the line can be guided onto the spool by this slide when the spool is reeling in. This will help to protect the line as well as the men who are working around it.



Modified Catline Spool Straightens Tangled Line

The storage spool for the catline on a rig has been modified by one company to assist the crew in maintaining this line free of entanglement. The outside rim, as shown in the picture, was modified to contain three notches so that the line could be inserted and rotated clockwise while being held fast in the opening. Usually 10 to 20 turns, with the line fastened on the disc, will straighten out any kinked and tangled line.

The spool is supported on a 2½-inch pipe, 25 inches in length, rotating on a two-inch shaft that is made up into a collar welded onto the drawworks. The outside end portion of the shaft can be made up with a two-inch half collar, which serves to lock the spool in position on the shaft. A one-half inch handle is

GREATER CLEARANCE

with

H C Smith

3-CUTTER ROCK BITS

means more hole faster!

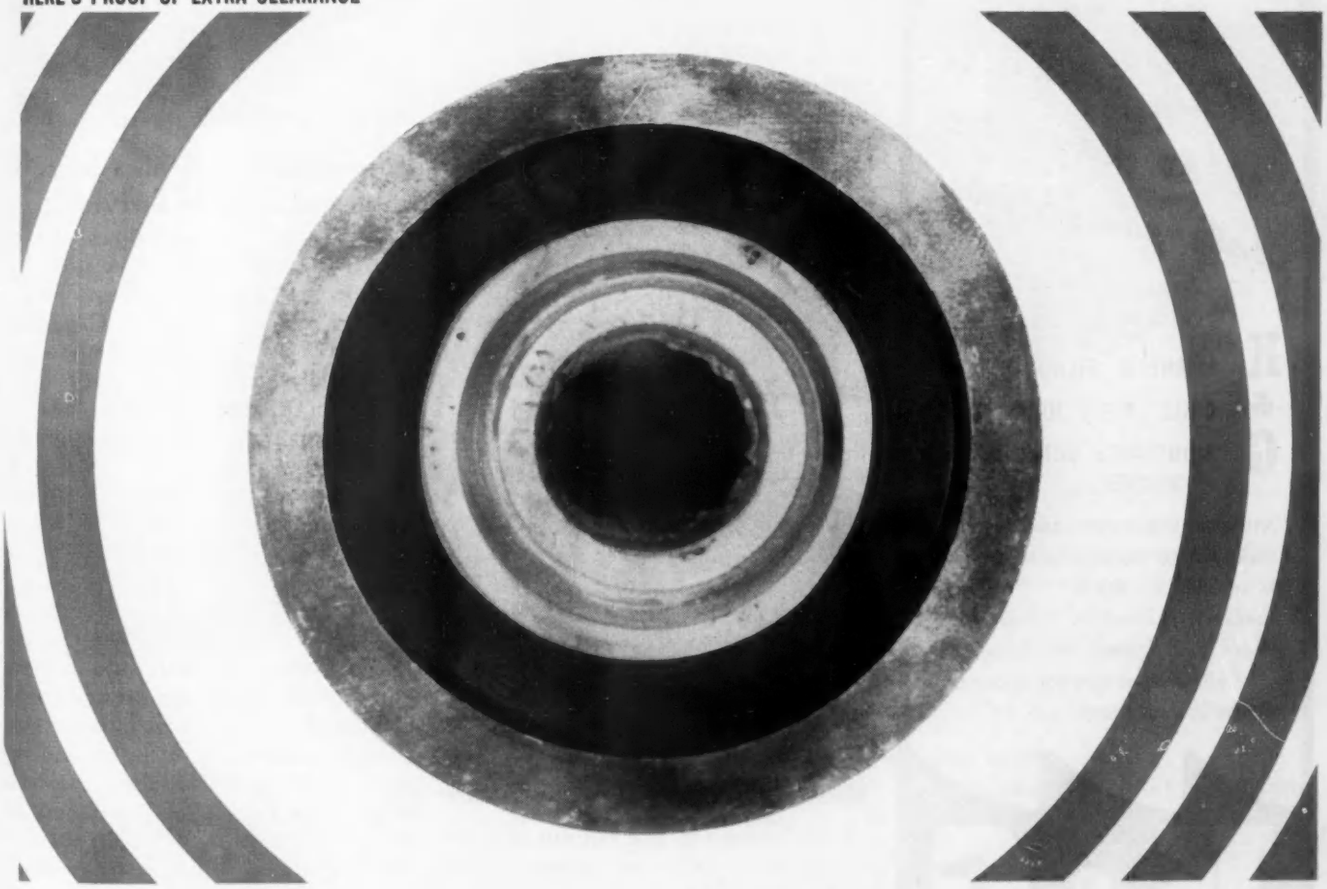
The compact bodies of H. C. Smith Rock Bits are functionally designed to give greater clearance between the bit and the wall of the hole.

Result — mud and cuttings clear away more rapidly . . . the teeth are always working on the **bottom**, making more hole — faster!

All jet bits offer advantages. But the greater their clearance, the more effective those advantages can be. The photograph shows an 8½" H. C. Smith 3-cutter bit placed in a section of $8\frac{17}{32}$"-I. D. machined tubing. Make your own comparison test and note the **extra clearance** you get with H. C. Smith Rock Bits.

One more reason why H. C. Smith Rock Bits are *- every bit the best*

HERE'S PROOF OF EXTRA CLEARANCE



GENERAL OFFICES, EXPORT OFFICES AND PLANT: COMPTON, CALIF.
BRANCHES IN ALL PRINCIPAL OIL CENTERS IN THE UNITED STATES AND CANADA

H C Smith
OIL TOOL CO.

Pioneers of successful magnetic fishing tools and methods

More Magnetic Fishing Jobs Successfully Completed With K & G Tools and Methods than with all other magnetic tools combined...

for satisfaction use

K & G MAGNETIC FISHING TOOLS
DRILL PIPE JUNK SHOT
ADJUSTABLE CORE BARREL MAGNET

Available in popular sizes from most major fishing tool companies. Be sure to see that it's K & G . . . the only company licensed to manufacture under U. S. Patent No. 2,668,077.

Call, write or wire for quotations on use in your area.

K & G
OIL TOOL and SERVICE COMPANY, Inc.
2703 Sackett • Houston 6, Texas
JA 2-5436

7345

pinned to two metal plates that are welded on the edge of the outside rim. The handle, approximately six inches in length, is cut from scrap one-half inch pipe and pinned through a hole in these welded metal plates.

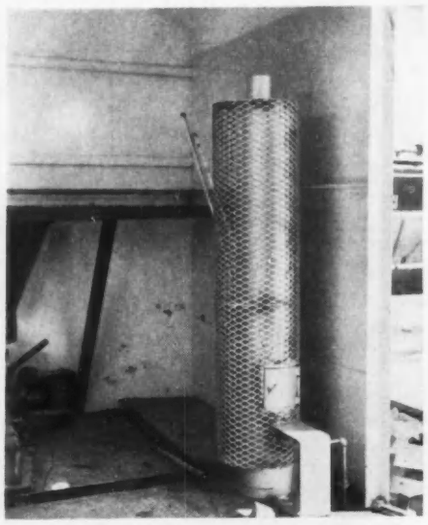
After a certain amount of use, a tangled and twisted catline is usually difficult to straighten before reeling back on the spool. This spooling device has speeded up the time required to straighten the line and reduced the hazard of unreeling a tangled line from the spool.

The crews, realizing the need for reduced hazards around a cathead, have appreciated the simple spool with its ease of operation.

Inexpensive Heater Guard Boosts Doghouse Safety

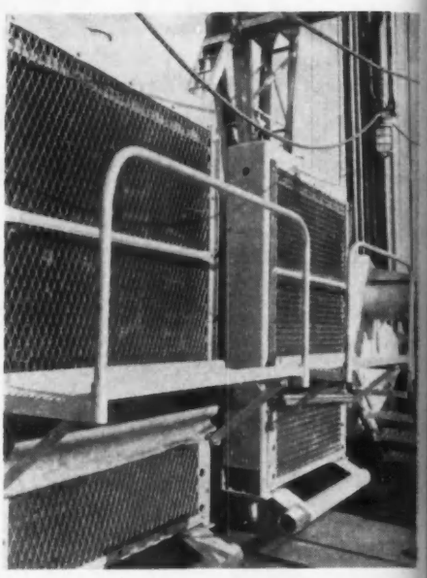
Expanded metal makes a good guard for the winter warmer. The simple construction can be done at the rig and cost is negligible. Some scrap plate and a length of expanded metal are the materials necessary for this needed safety device. Three half moon sections are cut from the plate so that the smaller diameter curve will fit the side of the heater and the outer diameter curve will hold the expanded metal away from the heater.

The half moon plates are welded



to the heater top and bottom and the third about half way between. The expanded metal is welded to the outer diameter of the half moon plates and the ends are welded to the heater. This forms an effective guard for the heater. An opening is cut from the expanded metal to allow the heater door to be opened and closed.

The gas line into the heater can be protected from possible damage by using a strip of plate bent in a square "U" shape as shown. The ends of the strip are welded to the heater so that the flat bottom of the "U" extends out and around the gas line. This effectively guards the gas line from being hit or damaged by the crew during work.



Demountable Walks Speed Engine Radiator Servicing

Temporary, and sometimes unsafe, ladders or walkways often used by rig personnel to service engine radiators are eliminated by a Canadian contractor. In place of the temporary measures, he constructs light, handrail equipped walkways made of angle iron and expanded metal treads.

These units, attached to the fronts of the radiators at convenient working height, are easily removed, being bolted to brackets welded to the fronts of the radiator shells. Only a few minutes are required to either install or remove the walkways at moving time. To insure against accidental kicking of tools or parts into the vulnerable radiator core, or to the rig floor walkway below, the three-inch angle iron longitudinal members of each unit, those to which the expanded metal treads are welded, were made to look upward, thus providing a curb.

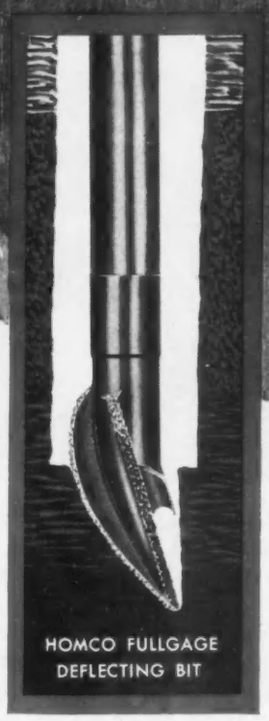
Easy positioning of the radiator curtains at any one of a half-dozen points is facilitated by burning upward-sloping slots at pre-determined intervals in the angle iron guides on either side of the radiator.

HOMCO

HOUSTON OIL FIELD MATERIAL COMPANY, Inc.

COMPLETE OFFSHORE DIRECTIONAL DRILLING

25 YEARS EXPERIENCE



HOMCO FULLGAGE DEFLECTING BIT

HOMCO has developed special tools to reduce Directional Drilling time on Tidelands operations. The HOMCO Fullgage Deflecting Bit saves several drilling days when used to directionally drill surface holes. Call the nearest HOMCO Directional office and learn how this tool can put a directional hole on course with one round trip of the drill string. This tool saves enough rig time to more than pay for the directional costs. The HOMCO Fullgage Deflecting Bit is "exclusive" with HOMCO.

HOMCO-Kuster Surveying Instruments—"An Unerring Guide to the Objective."

Other HOMCO Directional Tools

Whipstocks and Mills • Slim Joints • Hole Openers • Rat Hole Guides Stabilizers • Keyseat Wipers

THE WORLD'S LARGEST INDEPENDENT OILFIELD SUPPLY AND SERVICE ORGANIZATION

DIRECTIONAL DRILLING • FISHING AND CUTTING • OILFIELD SUPPLIES • ELECTRICAL WELL SERVICE

HOMCO

HOUSTON OIL FIELD MATERIAL COMPANY, Inc.

HOUSTON, TEXAS

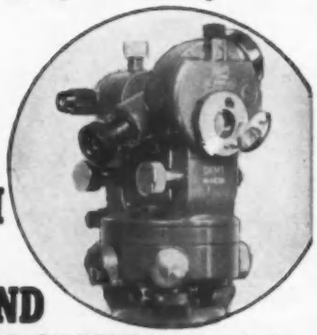
SIDETRACKING - STRAIGHTENING SURVEYING

RESEARCH • ENGINEERING
DEVELOPING • MANUFACTURING

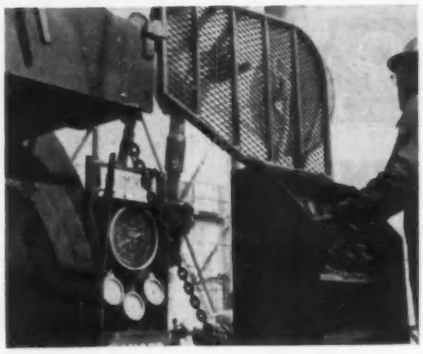
HOMCO Export Offices

Houston Oil Field Material Company, Inc.
509 Madison Avenue
New York City, New York

HOMCO de Mexico, S. A.
Paseo de la Reforma #76, desp. 503
Mexico 6, D. F.

*IN TEXAS
...AND THE WORLD OVER
KERN
SURVEYING INSTRUMENTS
*The Bridge Division of the State of Texas Highway Dept. uses Kern Instruments
WORLD FAMOUS FOR
Working Speed
Operational Simplicity
Accuracy & Economy

DKMI TEN SECOND THEODOLITE (with optical micrometer)
• Exceptional portability and precision.
• Readings automatically ... AT A GLANCE.
• Direct reading to 10". Estimation to 1". Average working accuracy —3-4 secs.
• Can be used with electric lighting unit for night work.
KERN CENTERING TRIPOD
Unique—a Kern first! Centers instruments in seconds with remarkable accuracy. Assures exceptional stability with ball-and-socket head, supporting instrument coupling

★
Write for Brochure DK 518 - 8
PROMPT, RELIABLE SERVICE
FACTORY TRAINED PERSONNEL
Kern SWISS
The Finest in SURVEYING EQUIPMENT
KERN INSTRUMENTS INC.
120 Grand St., White Plains, N.Y.



Face Guard for Driller Cuts Down on Rig Danger

A necessary safety device around a rig and a more complete protection for the driller can be obtained by use of scrap pipe, a few small pieces of scrap plate and some expanded metal. The photograph shows how one driller maintains a good guard from the backup chain and flying objects on the derrick floor and still is able to see what is going on. The construction is very strong and very easy for the welder. The small diameter pipe is shaped as a frame and welded.

In this case, the shape is rather odd to fit to the outlet of the backup chain. The frame is then set on the driller's console cover guard so that it will be in front of his face and guard him from the swing or break of the backup chain. A small arm of scrap is welded to the guard of the back-off roller, and a small loop is built that is welded to the frame of the face guard and at the same time the guard is bolted to the driller's console.

The frame is strengthened by means of brace work welded inside the frame. Expanded metal is welded to the frame to complete the guard. This makes a strong and effective guard and does not obstruct the driller's vision.

How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Mud Gun Stand Relieves High Pressure Line Strain

The mud gun stand shown in the photograph is a good method of protecting the mud gun which is often held in position by its own connections. The stand will relieve part of the strain on the high pressure mud line.

The stand is constructed of angle iron and scrap plate. To construct the stand, a square piece of scrap plate is used as a base. At each of the four corners, short pieces of angle iron are welded so that they form the sides of a pyramid. A very short piece of small diameter pipe is used at the top of the angle irons to bring them together and leave clearance for the line to the mud gun. The base of the mud gun is positioned on saddle angle

iron and held by U-clamps. Angle iron saddles are set on either side of the bottom tee and welded into position.

Short pieces of pipe are brought off of the tee to rest on the bent plate. U-clamps are placed around the short pipes to hold the lower tee in position. The upper tee is screwed onto the lower tee in a vertical position by means of a short piece of pipe. From this tee a valve and a short piece of pipe are connected.

A piece of angle iron is welded to the two nearest angle iron sides and the short joint of pipe rested on this piece of angle iron. A U-clamp is used on this short joint of pipe to hold it in position. This stand facilitates the use of the mud gun in mixing as well as making a good storage and holder while the mud gun is not in use or is being moved.

PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

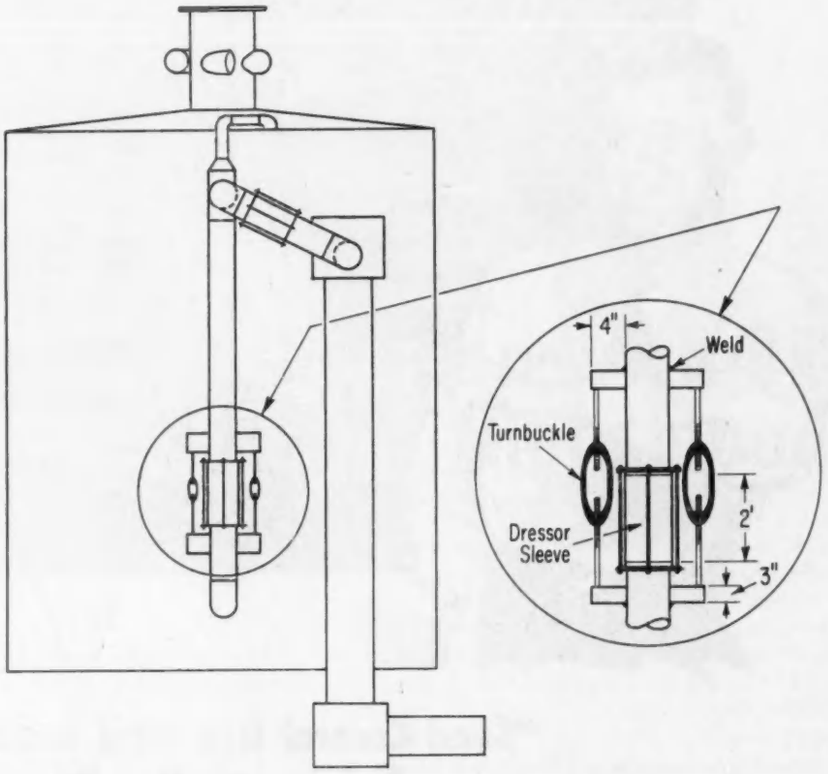
$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Mount Tool Receptacle On Catwalk Structure

Storage containers have been placed at various positions around a battery. Regardless of whether the pumper considers the receptacle more conveniently located at the main entrance or at a particular spot on the catwalk, it is one of the more popularly used items around a battery installation.

A handy receptacle for storage of the gage line, and wiping rags can be made from a square gallon can. Preparation for the container requires only cutting out the top with a can opener and punching several holes for fastening. It can be bolted through these holes in a convenient spot on the stairway or catwalk structure as shown in the photograph.

A storage place for the pumper's tools makes his job easier and more enjoyable. Although the breakage of small items such as thief samplers and the losing of other small tools do not seem significant at the time of occurrence, the replacement cost amounts to a significant figure over a period of time. This cost would seemingly be reduced if tools were properly stored.



Turnbuckle Simplifies Siphon Adjustment

Unsettled lease production often necessitates frequent adjustment of the siphon to lower or raise the oil-water contact in the gun barrel. A simple, safe and quickly adjusted turnbuckle installation employed by one company has made the pumper's job easier, created better safety conditions and reduced lease operating costs. One company reported cost of the average installation at $25, resulting in an estimated annual savings of $27 when based on three siphon adjustments at $9 each. The one-man operated turnbuckle eliminated the need for a truck with gin poles and crew, previously necessary when it was desirable to raise or lower the oil-water contact.

The adjusting apparatus can easily be fabricated from scrap steel and a turnbuckle. The siphon adjuster is installed on the vertical line, above the outlet near the bottom of the gun barrel and also on the connecting, siphon-water leg horizontal line as shown in the drawing. Pipe sleeves are used in both the vertical and horizontal sections to allow travel for raising and lowering the siphon line.

A three-inch piece of angle iron, approximately one foot in length, is

"Sand Control is a vital factor in the success of any water flooding operation!"

The Layne gravel packing technique has proved to be the most completely satisfactory method of sand control to date. So it can well be the vital factor in all three phases of your flooding operation.

1 The supply well should be gravel packed during the first phase to eliminate the possibility of sand being pumped into the water flooding input well.

2 During the second or input phase, the well should be gravel packed to reduce the velocity of the water as it enters the formation and thereby hold the formation wall intact. Gravel packing also reduces the pressure required to put the water into the formation by increasing the inlet area at the sand-gravel interface. This allows flooding with greater volumes of water.

3 For the third or producing phase, gravel packing provides insurance for trouble-free production. The sands of most producing formations are held together by a bonding action, but when water encroachment occurs, whether natural or induced, this bonding or cementing action is broken down leaving the sand free to move into the well bore with the fluid.

THE LAYNE AND BOWLER COMPANY

P. O. BOX 1327, HOUSTON 1, TEXAS

THE LAYNE

welded across the back of the vertical siphon line above the outlet at the bottom of the gun barrel for attachment of the turnbuckle rods. The upper horizontal section is made up in a similar manner. Top of the siphon line, swedged down to a smaller vent line, is connected back into the top of the gun barrel. This line must extend a sufficient length into the gun barrel to allow the raising and lowering adjustment. A sleeve is provided on the horizontal line from the siphon to the water leg so that the water leg can be maintained in a fixed position and still allow travel in the vertical siphon line.

Platform Keeps Equipment Above Water During Flood

If your production lease is subject to sudden destructive flooding, the pumps on shallow wells can be mounted on a platform a sufficient distance above the ground to insure its being above water during flood.

The photo shows a well in the Ohio River Valley of West Virginia that has been equipped to raise the pump and power above the high water being encountered in this area.

The platform is built of expanded metal ditching, angle iron, pipe and concrete. The entire structure can be fabricated in the shop for field assembly. The substructure is in two parts—the deck guard rails and ladder as components to be welded together at the well site.

In assembly the two sides of the substructure are welded together and all the cross bracing is welded in place. The substructure is set up and the concrete is poured with time being allowed for the concrete to cure. Then the floor of the platform is lifted up and welded into place. The ladder is set and welded, and the guard rails are put up last. Be sure to set the ladder and substructure upstream of the well to act as a fender for flood trash.

How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

men with Oil in their blood

Seldom do Legrand users have a change of heart, they know the importance of rugged, dependable pumping equipment. Available to meet all oilfield pumping demands are units from 3,000 lbs. to 33,000 lbs. polished rod load and 24" to 132" stroke. All units are floor clearing with rack-and-pinion balance weight adjustment, API Standard gear reducers, LEGRAND patented double-taper wristpins, self-aligning equalizer and wristpin bearings, lateral and fore-and-aft beam adjustment, swing back mulehead, LEGRAND patented carrier bar, ground level lubrication, all bolting in "Unified" series. Incorporating the most up-to-date design features LEGRAND Pumping Units are the result of long practical experience in the Oil Fields of the World.

LEGRAND

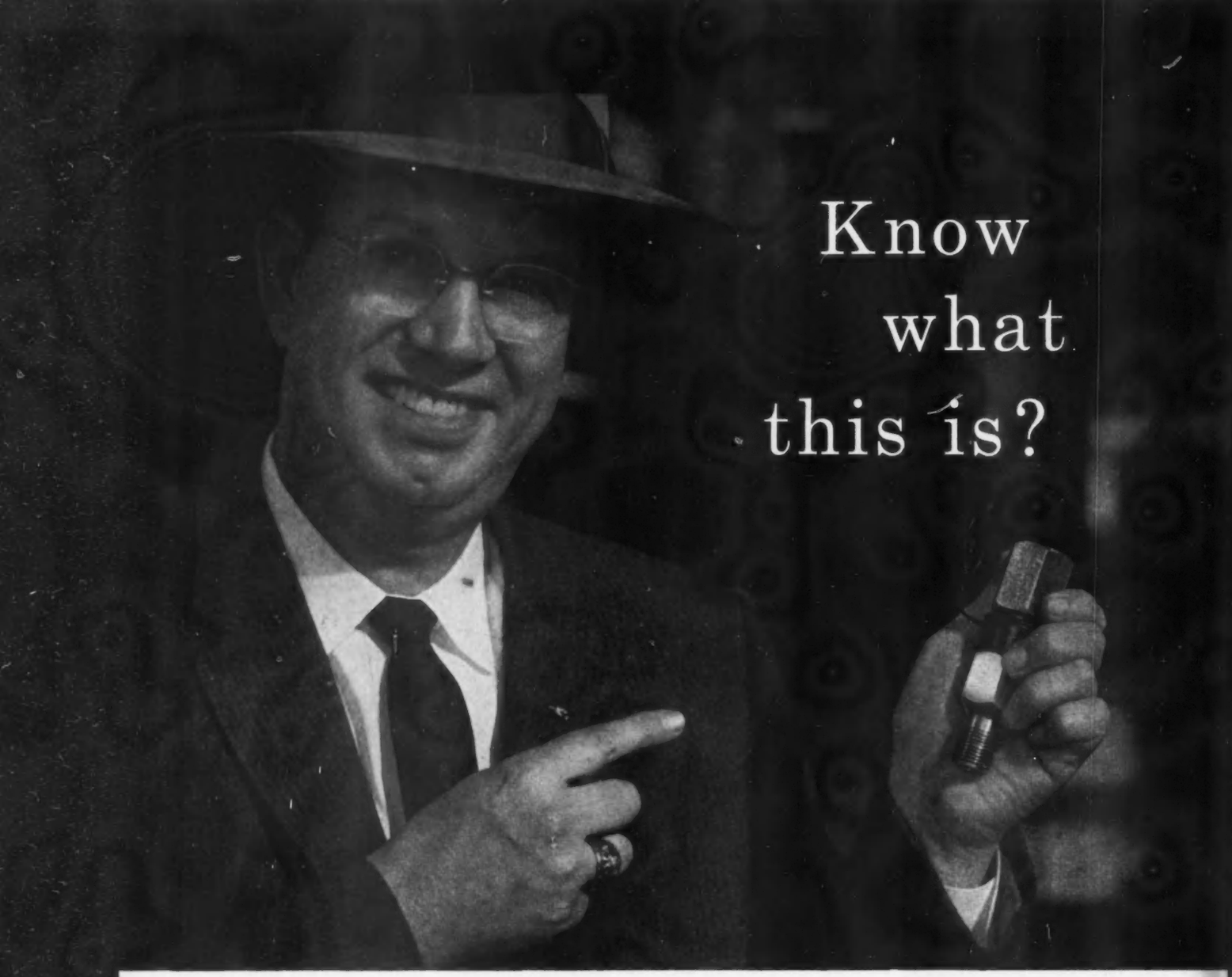
also Manufacturers of LEGRAND-O.C.T. Wellhead Equipment: LEGRAND-HOWCO Floating Equipment: LEGRAND-S.C. CARTER Long-stroke Hydraulic Pumping Units.

LE GRAND ROCHESTER LIMITED
HORSTED AIRPORT • ROCHESTER • KENT • ENGLAND
Telephone: CHATHAM 44626

Represented in the following areas by Agents who will be pleased assist you.

CANADA	TRINIDAD	VENEZUELA	
		Eastern	*Western*
Le Grand Ltd., 111-58th Avenue South West, Calgary, Alberta.	Industrial Agencies Ltd., 14 High Street, San Fernando, Trinidad, B.W.I.	A-Z Export, S.A. Apartado 4026, Puerto La Cruz, E. Venezuela.	A-Z Export, S.A. Apartado 304, Maracaibo, W. Venezuela.

For more data on advertised products, use Readers' Service Cards, last page.



It's a real slick little tool that can save you a lot of fixed capital investment - and bother - each year.

To obtain well pressure reading, insert master gauge with Connector in Gauge Valve and turn gauge 45 degrees. Gauge Valve opens automatically, exposing gauge to pressure. Remove gauge and Gauge Valve closes automatically.

HERE'S HOW IT WORKS: Instead of buying one or two pressure gauges for each Christmas tree, you buy just one master gauge *for an entire field.* Then, install these inexpensive Gauge Valves where you have been installing permanent type gauges—one on the tubing and one on the casing. Your Gauger takes the master gauge from well to well, stabs it into the Gauge Valve to obtain the pressure reading.

Only one gauge to buy.
No breakage.
No gauge repairs.
No exposure to elements.
No inaccurate pressure readings.

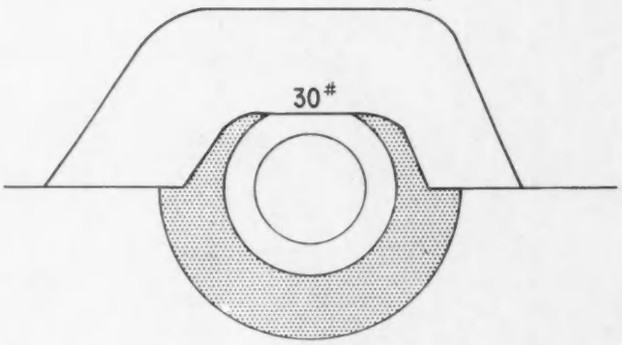
Ask any UNIBOLT man to demonstrate the Gauge Valve and Connector, or write:

THORNHILL UNIBOLT CRAVER CO.

P. O. BOX 1184 • HOUSTON, TEXAS

Indicate Tire Pressure on Truck Fender

In large companies where vehicle operators use different trucks for various jobs, the driver is often confused over the correct tire pressure. Pick-up, gang-truck, float and trailer tires are of various sizes; therefore recommended pressures by the manufacturer will vary considerably for each size tire. A driver, involved in operations that require his use of different company vehicles, would very likely fail to remember the correct tire pressure for each type vehicle.



One operator, realizing this condition, established a system to insure that the correct tire pressure was applied by service station attendants or new employes. The correct tire pressure was stenciled with paint on the fender above each wheel on all company vehicles. There was never any further question concerning the correct tire pressure, regardless of the unit to be serviced. This system increased the tire life on all units and also made drivers and employes servicing the equipment more conscious of the importance of correct tire air pressure.

The number, indicating the proper tire pressure, can be placed on the outside lower portion of the fender and centered above the wheel. It should be painted on the fender surface with a pre-cut stencil or neatly lettered by hand.

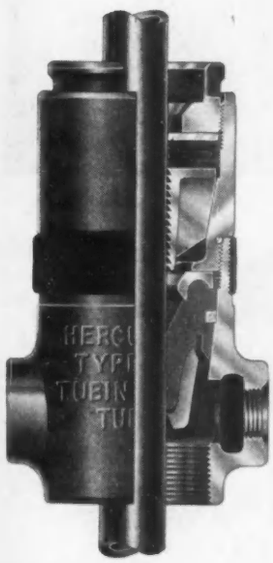
Simple Ladder Convenient For Wellhead Maintenance

Various pumping devices or lubricators often present a problem when it is necesary to get to the top of this type equipment at the wellhead for maintenance, lubrication or adjustment. An answer for one operator was this simple shopmade ladder, installed as illustrated in the picture.

The ladder was made of two-inch pipe, approximately ten feet in length with short, steel rod steps welded perpendicular to the pipe and spaced at convenient intervals. A tee is made up on the threaded section at the top of the two-inch pipe for support. Wire, chain or rope can be run through the

You get the most ECONOMICAL SERVICE from...

HERCULES TUBING HEADS

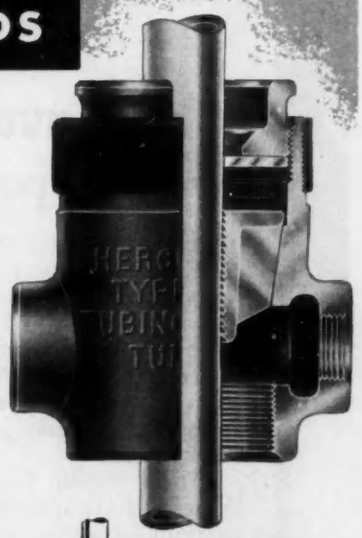


"TYPE J-5" TUBING HEAD

Ideal for flowing or pumping wells or for well servicing and repressuring projects. Will suspend 2" tubing to 5½" casing up to maximum of 180,000 pounds. Head is full-opening; constructed of pressure cast steel tested to over 4,000 psi. HERCULES original overhead packing arrangement and hinged slips facilitate installation and servicing. HERCULES Neoprene Tubing Stripper (2" - 2½" - 3") may be used in this head on wells flowing intermittently or to wipe tubing. Equipped with safety threads.

"TYPE J-5-S" STRIPPER TUBING HEAD

The dual purpose "Type J-5-S" Stripper Tubing Head is basically a "Type J-5" Tubing Head with a bowl (top section) screwed into the packing nut thread. The hinged slips, packing and packing nut are installed in the bowl (top section) with the tubing stripper in the body (lower section), thus permitting tubing to be run-in or removed under pressure. Test pressure is the same as the "Type J-5" Tubing Head.



HERCULES TOOL Company

Available through all supply stores

"MANUFACTURERS OF OIL FIELD EQUIPMENT SINCE 1924"

GENERAL OFFICES AND PLANT TULSA, OKLAHOMA

Export Representative: Oil Field Equipment Co., Inc., 30 Church Street, New York 7, N. Y.

Ten Ingersoll-Rand PJVG gas engines provide low maintenance and high availability in flood pump service

These ten Ingersoll-Rand PJVG gas engines are driving high pressure water flood pumps at Gulf Oil Corporation's North Ward-Estes Unit, Wickett, Texas. They have been in continuous service since December, 1954, and service attention has been held to a very satisfactory minimum. Three additional units are on order.

These 295-hp four-cycle, V-angle engines include automatic speed control for varying water volume and pressure.

For service-proved dependability in round-the-clock service—with smooth control and long-run economy—look into the advantages of Ingersoll-Rand 4-cycle V-angle gas engines. They are available in sizes from 220 to 2000 hp. Ask your I-R representative for complete details.

4-CYCLE

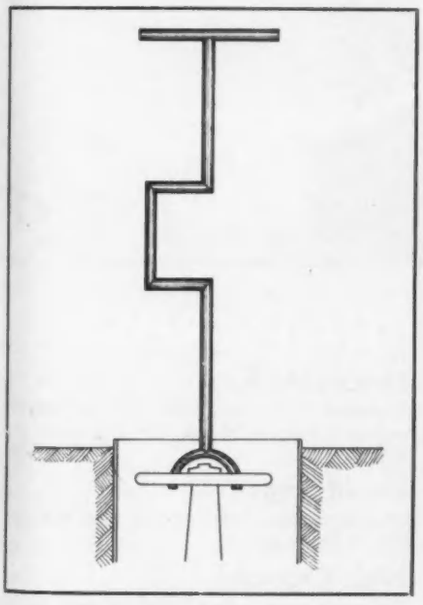
Ingersoll-Rand

6-709 11 Broadway • New York 4, N.Y.

COMPRESSORS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS
PUMPS • CONDENSERS • ROCK DRILLS • VACUUM EQUIPMENT

tee and the ladder tied down in position around the lubricator or pumping device.

For a temporary installation, the ladder adequately serves the same purpose as a fixed elevated platform. The fixed, more expensive platform, is not essential unless a permanent type installation is desired.



Shopmade Tool Handy To Open-Close Valves

A handy tool used by one company around a tank battery or manifold to open and close gate valves has increased the speed and ease of operation for the pumper or switcher. The tool adaptable to any-type hand wheel operated valve takes the strain off the pumper when opening or closing valves in inaccessible places. The tool also speeds the time required to operate any valve with a handwheel. It is especially useful on valves close to

The Simplest Gas Lift Valve on the Market

2 ONLY TWO MOVING PARTS

NEW OTIS TYPE F RETRIEVABLE GAS LIFT VALVE

This is a completely new, different gas lift valve . . . a tool gas lift men have been wanting to run for years. It has only two moving parts . . . no metal moving parts. There are no valve seats to cut out . . . no metal bellows to fatigue. The same valve can be used for either continuous or intermittent lift, just by making a simple change at the wellhead; no need to buy another string of valves to convert a system — a simple solution to borderline wells (one-third of the gas lift wells on the Gulf Coast).

The new Otis retrievable valve has a much greater dome area than any other pressure-operated valve. This permits a softer acting valve that is fully open with a 10- or 15-pound build-up above the set pressure. The Type F is a completely balanced valve with respect to the opening and closing at the same pressure. It has no uncontrolled spread, which means that the operator has complete control of the gas that is injected at the surface, on either continuous or intermittent lift. The Type F is run with a standard kick-over tool and lands in a standard side-pocket gas lift mandrel.

All in all, you will find this new valve to be the most efficient, flexible gas lift valve on the market, with many operating features not available in any other equipment. Your nearest Otis office will be glad to give you additional details and illustrated literature without obligation.

OTIS ENGINEERING CORPORATION

Branches Throughout the Oil Country

PRESSURE CONTROL · OTIS · SERVICE – EQUIPMENT

No . . . These Are All BS&B Spherical Separators Efficiently Performing On A Gulf Oil Corp. Lease!

Although at first glance the above installation might appear to be a launching area for earth satellites, it is in reality a battery of 18 BS&B Model "OGS" Spherical Separators.

Located at Gulf Oil Corporation's Consolidated Tank Battery #4, Citronelle, Mobile County, Alabama, each of these units is 41 inches in diameter and has a nominal working pressure of 125 psi. Throughput of each separator is approximately 500 bbls. of 43 to 36 gravity oil daily.

Also available in shell diameters of from 24 to 54 inches and in working pressures ranging from 125 to 6,000 psi, these Model "OGS" units are of an exclusive BS&B design which takes full advantage of the spherical characteristics of the separator to give maximum separation efficiency.

FEATURES

1. **Simple Hookup**
   Connections to top inlet and bottom outlets are easily made from any direction.
2. **Liquid Slugs**
   Internal design diverts liquid slugs rapidly to liquid section.
3. **High Capacity**
   The large area of liquid surface area to volume in the liquid section allows rapid release of solution gas from the oil.
4. **Controls**
   All Controls and valves are BS&B.
5. **Compact Design**
   Small space requirement of the Model "OGS" is a distinct advantage over other separators.
6. **Servicing**
   Convenient access openings are provided to simplify periodic cleaning and blow-down.

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

For Full Information On The BS&B Model "OGS" Spherical Separator, Contact Your BS&B Representative, Or Write To...

BLACK, SIVALLS & BRYSON, INC.

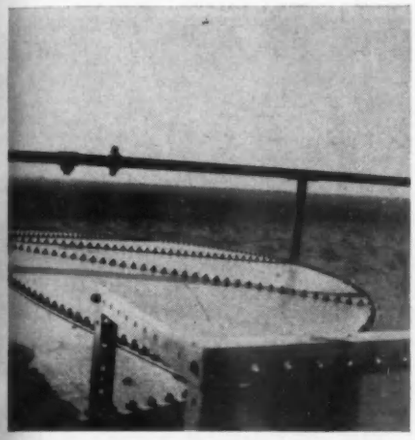
Oilfield Equipment Division, Dept. 1-B1

P. O. Box 1714

Oklahoma City, Oklahoma

ground level or below ground level where hand space required to open and close valves is at a minimum.

The wrench can be made in the shop from a scrap one-half inch rod, two to three feet in length. A piece of metal, shaped into a "Y" or semi-circle, is welded to the bottom end of the tool. This part of the tool is inserted over the hand wheel, as illustrated in the drawing, when it is desirable to operate a valve.



Support Vent-Exhaust Line From Storage Tank Top

Exhaust, vent or breather lines run from storage tanks usually require support at various intervals. The method employed on this battery is both simple and effective.

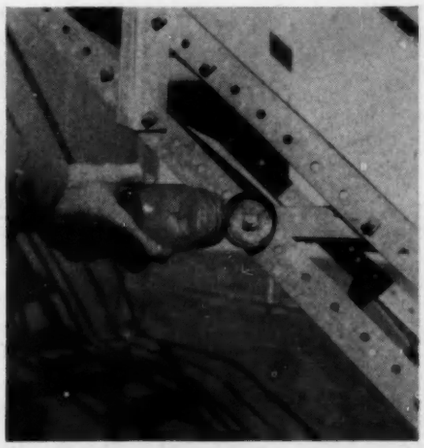
A piece of two-inch pipe, cut to desired length has a seat welded to one end and a small plate welded to the other. The seat is a six-inch piece of 2½-inch pipe split in half lengthwise, forming a saddle support. The support's base plate is two inches wide and is cut long enough to use the tank bolts for attachment to the tank through holes cut in the base.

This method of support eliminates the use of extra pipe for the more popular method of running support piping to ground level. A very common method of providing support for vent lines is to use a tee tied in to a vertical line. This vertical support is capped with a bull plug at the base and buried below ground level, usually between tanks. This means of providing support for vent piping requires additional pipe and results in higher ultimate cost for the installation. A shorter support, as illustrated in the photograph, will adequately serve the same purpose.

Mount Run Ticket Bottle On Hand Rail of Stairway

The idea of using a container to provide convenient out of the weather storage for reports, notes or run tickets around a tank battery installation is not new. Any number of types of containers for this use can be observed in the field from scrap to mailboxes.

If the operator does not wish to stand the expense of having a welder make up a fancy container for installation at a convenient spot around the



PROVED . . . IN THE FIELD!

JENSEN'S No. 5 JACK

This newest member of the JENSEN family of jacks has been thoroughly tested and PROVED to lift oil efficiently and economically—like the other 13 sizes of JENSENS.

It's specially engineered for wells from 1,000 to 1,500 feet. So, if you have a shallow well and want to pump MORE oil for LESS money, install a JENSEN No. 5 JACK. It incorporates all the time-tested features that make JENSEN JACKS your best buy.

Visit your nearest supply store and get all the facts about JENSEN'S No. 5 JACK.

STOCKED BY YOUR LOCAL SUPPLY STORE

Made by JENSEN BROS. MFG. CO., INC., P. O. Box 477-D, Coffeyville, Kansas

Export Office: 60 East 42nd St., New York City, U. S. A.

JENSEN JACKS

For more data on advertised products, use Readers' Service Cards, last page.

Can These Super-Hard Ball Valves Correct Your Pump Trouble?

If you have troublesome wells on your lease . . . wells that are hard to keep pumps in due to corrosive or abrasive fluids . . . and if the cause of your pump trouble is in the valves . . . the next time you're in your supply store ask them to show you a set of DuMore® Balls and Seats.

DuMore is a super-hard alloy composition that affords the highest resistance to wear caused by sand cutting, corrosion, or ball pounding. DuMore Balls and Seats are non-magnetic, they are corrosion-proof, and they run especially well in sour or sweet crudes, hydrogen sulphide gas, or salt water brine.

Considering its unusual metallurgical properties (an alloy of chromium, cobalt, and tungsten), it's a bargain at any price . . . yet DuMore costs less than premium grade ball valves. Moreover, the expenses you would eliminate in one pulling job alone would more than pay for fitting out your pump with DuMore Balls and Seats.

Try DuMore the next time you run a pump. You will be more than satisfied with the service they will give you, and you will agree that it's the "Best Ball and Seat in the Oil Patch."

DuMore® Balls and Seats

Made by **Harbison-Fischer • Fort Worth**

"Best Balls and Seats in the Oil Patch"

battery, the idea illustrated in the photograph is a simple, effective and adequate way of solving the problem. The lid from a glass jar can be mounted at a convenient spot on the hand rail or vertical rail member, of the stairway or catwalk. One hole cut in the center of the lid serves as a place for mounting with a bolt contained in the structure.

Where a standard size jar is used, replacement can easily be made in case of breakage.

Scraper Reduces Hazard Of Mud on Tank Walk

The mud around a tank battery, resulting from bad weather or overflow, can be dangerous if carried to the top of the walk-way by a gager. Mud lined walk-ways tend to quickly create hazardous footing and create bad appearance around the installation. To assure better footing on the stairway or catwalk, one lease operator installed this boot scraper at the foot of each set of stairs. Any scrap piece of metal can be employed for use as the scraper by driving it into the ground and imbedding it in concrete when pouring the walk or steps around a battery installation.

Scrapers are also useful in many places around the field. Installing them on steps to the pumper's shack, dressing room and field office result in more easily maintained quarters.

Copies of World Oil and The Oil Weekly Since 1943 Available

A subscriber is willing to make available a complete set of *The Oil Weekly* from 1943 to 1947 and a complete set of WORLD OIL from its inception in 1947 to date. The only expense would be express or freight charge from Houston. Any organization or individual desiring these copies should address Circulation Manager, WORLD OIL, Box 2608, Houston 1, Texas.

What's Happening

among MEN in the INDUSTRY

Carl E. Reistle, Jr., of Houston, executive vice president of Humble Oil & Refining Co., has been named by the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME) to receive the Anthony F. Lucas Gold Medal, a major award of the Institute and an outstanding honor in petroleum engineering. Reistle, a former president of AIME and the author of many technical papers, will receive the award the evening of Feb. 19, 1958, at the annual banquet of AIME in New York.

•

Frank B. Gray, Jr., and **C. E. Gordon** have been elected vice presidents of the **Caran Engineering Corporation** and its foreign subsidiary, **International Exploration, Inc.** Gray also serves as chief engineer in charge of the Spectrometric Mud Logging division. Gordon, who was one of the founders of the companies, has been in charge of design and manufacturing of special instrumentation.

•

William W. Clawson, coordinator of domestic production for Socony Mobil Oil Company, Inc., became a member of the **Magnolia Petroleum Company** management, with headquarters in Dallas. In his new position, Clawson will be responsible for coordinating Magnolia's exploration and producing activities. Clawson was employed by Magnolia from 1933 through 1952, the last six years as chief geologist. In 1953, he became manager of Socony Mobil's Pegasus division in Billings, Mont., and president of Socony-Vacuum Exploration Company. In 1955, when Mobil Producing Company was incorporated to take over the operations of the Pegasus division, he became president of that company also.

William W. Clawson

•

Robert C. Hagens has resigned as production superintendent, American Petrofina, Inc., Corpus Christi, Texas, to become drilling and production superintendent, **Coloma Oil and Gas Company**, Corpus Christi. He was with Stanolind Oil and Gas Company 1945-1952 and with Alcoa during 1953 before going with Panhandle Oil Corporation (American Petrofina, Inc.). He is chairman of the Southwest Texas Section, Society of Petroleum Engineers of AIME.

P. A. Chester

A. W. Tarkington

P. A. Chester and **A. W. Tarkington** were elected to the board of directors of **Continental Oil Company.** Chester is managing director of Hudson's Bay Company, Winnipeg, and Tarkington is senior vice president of Continental Oil. Chester joined Hudson's Bay in London in 1923 and was transferred to Canada in 1924. He became general manager in 1930 and managing director in 1952. Tarkington joined Conoco at Ponca City, Okla., as treasurer in 1948 and two years later was named assistant to the president, with headquarters in Houston. He was elected vice president and central region general manager at Oklahoma City in 1951 and transferred to Fort Worth, Texas, in 1953 as vice president and southwestern region general manager. He returned to Houston in 1956 as senior vice president.

•

Kenneth C. Cottingham retired recently as chief geologist of **Ohio Fuel Gas Company** and is now engaged in petroleum consulting in Columbus, Ohio. **Lysle Kirk** replaced Cottingham as chief geologist for Ohio Fuel.

•

Robert Wesselhoeft, Jr., recently resigned his position as staff geologist with Drilling and Exploration Company, Inc., to become an independent consultant. He will be associated with **A. B. See Drilling Co., Inc.**, Abilene, Texas. He had been with Drilling and Exploration Company, Inc., for 17 years, working at different times for the Drilling Production and Geological departments, from California to the Texas Gulf Coast.

•

William L. Bolles has been appointed an engineering manager in the Engineering department, **Lion Oil Company Division** of Monsanto Chemical Company. Bolles, who has been assistant manager in charge of process design in the Engineering department of Monsanto Chemical Company's Plastics division at Texas City since 1954,

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

ABILENE, TEXAS
Hudson-Eads, Inc. .....OR 2-5331
BAY CITY, TEXAS
J. P. Graham.....CI 5-4526
BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc....TE 5-7046, ZF 8-2023
CASPER, WYOMING
C. A. White.....3-5264
GLENDIVE, MONTANA
C. A. White.....EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5396
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc.....CA 5-1103
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc.....5541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....CE 5-6770
LIBERAL, KANSAS
Rainbo Service .....Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co.....530
MIDLAND, TEXAS
Lucous Service & Eqpt. Co.....MU 2-1631
NEW ORLEANS, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....VE 5-4983
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. 2-3767, 2-8584, 3-4690

Just Off the Press

1958 OIL DIRECTORIES

16 pocket-size, plastic-bound personnel directories covering the entire oil industry of the world, from top executives to foremen. Over 110,000 key men are listed. First eight books cover Producing and Drilling Contracting.

WE SEND OUR DIRECTORIES ON APPROVAL

1. Texas
2. Oklahoma
3. California
4. Kansas
5. Mich.-Ill.-Ind.-Ky.
6. La.-Ark.-Miss.-Ga.-Fla.
7. Rocky Mountain Region and New Mexico
8. Oil Well Drilling Contractors (Covers the World)
9. Water-Flooding and Offshore Operations
10. Refining, Petrochemical, and Natural Gas Processing Plants of the World
11. Pipe Line Companies and Pipe Line Contractors (Covers the World)
12. Oil Directory of Companies Outside the U. S. A. and Canada
13. Oil Directory of Canada
14. Directory of Geophysical and Oil Companies Who Use Geophysical Service
15. Directory of Oil Well Supply Companies (Covers the World)
16. Oil Directory of Houston, Texas

MIDWEST OIL REGISTER

DRAWER 7248, TULSA, OKLAHOMA

C. L. Cooper, Publisher

FOR QUICK RESULTS TRY A WORLD OIL CLASSIFIED AD

transferred to Lion recently. In his new position he will be stationed at El Dorado, Ark.

•

Arthur L. Martin, Jr.

Arthur L. Martin, Jr., has been promoted to division drilling superintendent of the West Texas-New Mexico division of **Delta Drilling Company.** Martin started in the oil fields with the J. C. Hawkins Drilling Company in 1948. He moved through the ranks of roughneck, driller and toolpusher, to his present position.

Robert D. Gordon has been elected to the board of **Rocky Petroleums Limited.** Gordon is a principal stockholder in Ashland Oil and Refining. The election of other directors include **E. Allan Graham, Robert N. Syer** and **Gordon K. Masters. T. J. Isaacs** was also named secretary and treasurer of the company.

•

Bandini Petroleum Company elected three new members to its board of directors. New board members are **Gen. Frederick L. Anderson, Edward H. Heller** and **Donald Royce. John P. Hurndall** and **R. H. Tecklenborg** continue as directors of Bandini. **William Lee Boyer** was elected vice president of the company.

Continental Illinois National Bank and Trust Company elected **Wallace W. Wilson** second vice president. He was employed by the bank as petroleum engineer in March, 1956. Prior to that time he was chief reservoir engineer and chief, reserves and evaluation section for Continental Oil Company in Houston. Wilson also worked as assistant professor of petroleum engineering at The University of Texas, research engineer for California Research Corporation, LaHabra, Calif., and petroleum engineer for the Ryder-Scott Company, Bradford, Penn.

W. W. Wilson

•

Continental Oil Company has promoted four men to new positions in its Southwestern region Exploration department. The men are **J. C. Cooper,** division geologist, promoted to the newly created position of assistant regional geologist, with headquarters at Fort Worth, Texas. **W. H. Fitzgerald,** division geologist, promoted to regional research geologist. He succeeds **C. D. Vertrees,** who retired recently. **J. L. Deffenbaugh,** Roswell, N. M., geologist, promoted to division geologist at Amarillo, succeeding Fitzgerald. **L. A. Dinges,** geologist, promoted to the newly created position of assistant division geologist for Conoco at Midland, Texas.

•

John K. Ontko has been promoted to regional geologist in charge of geological activities in the Calgary regional office of **Plymouth Oil Company.** Ontko had been employed by Pacific Petroleum, Ltd., and Royalite Oil Co., Ltd., prior to joining Plymouth Oil Company in 1956.

•

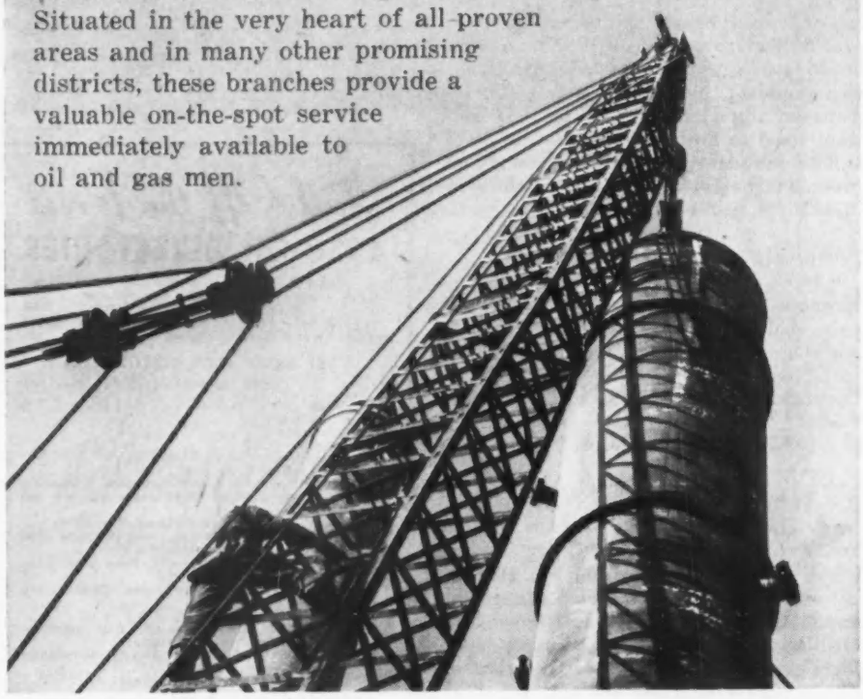
Alex W. McCoy Associates, Inc., has expanded its technical staff. Three geologists and two engineers have been added to the Tulsa and Calgary, Alberta, Canada, offices. Joining the Tulsa office are **F. M. (Mac) Stewart,** former staff engineer and specialist in reservoir engineering for Pan American Petroleum Corp.; **Myron L. Vance,** former geologist for Sunray Mid-Continent Oil Co., and **O. Lewis Smith,** former division petroleum engineer for Sun Oil Co. New men for the Calgary office are **Elmer L. Herbaly,** who until joining McCoy was zone geologist for Gulf Oil Corp., and **William Slemko,** who also was a geologist for British American Oil Co.

•

William C. Bednar, former partner in the now-dissolved firm of Meyer and Achschin,

Let the "Royal"
give you on-the-spot help
in Canada's Oil and Gas Fields

The Royal Bank has been close to Canada's oil and gas industry since the '20's — now operates over 300 branches in the oil and gas rich western provinces. Situated in the very heart of all proven areas and in many other promising districts, these branches provide a valuable on-the-spot service immediately available to oil and gas men.



Write to The Royal Bank of Canada, Oil and Gas Department, 409 Eighth Avenue West, Calgary, Alberta, for a list of current *"Oil and Gas Bulletins"*. These "Bulletins" are revised constantly, will bring you up to date on regulations, tariffs, oil and gas financing, basic statistics, and kindred subjects.

We do not provide information on oil securities.

573

THE ROYAL BANK OF CANADA

Head Office: Montreal. New York Agency — 68 William Street, New York 5, N. Y.
Over 900 branches in Canada, West Indies, Central and South America.
Offices in New York, London and Paris. Correspondents the world over.
Total Assets exceed 3½ billion dollars

When pressures run HIGH

Your Well Is Safe With

RECTORHEADS

the head that seals with the Ring-of-Steel

More than 125,000 Rector casing head installations prove that you can forget about pressure leaks when your well is equipped with Rectorheads. For working pressures to 15,000 psi . . . regardless of temperature extremes . . . the Rector ring-of-steel provides a lifetime seal.

There is no resilient packing to flow under pressure or deteriorate from heat or time. The casing is welded to a steel ring that fits in a precision ground seat. There is no stress on the weld when the flange bolts are tightened. A steel API ring gasket completes the permanent, maintenance-free seal.

For well safety and long range economy, specify RECTORHEADS . . . now in sizes through 20". Order from your favorite SUPPLY STORE.

P·E·S·A PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION PARTNERS IN PETROLEUM PROGRESS

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

EXPORT REPRESENTATIVES: Continental Supply Company • Mid-Continent Supply Company • Oil Well Supply Company

has announced the opening of petroleum consulting offices in the Republic National Bank Building, Dallas. He has retained access to the library of the former firm of Meyer and Achschin. Bednar worked for Amerada Petroleum Corp. for the three years beginning in 1935. From 1938 to 1943 he served as assistant professor, then associate professor on the petroleum engineering faculty of the University of Oklahoma. He was employed as a consulting engineer for the Oil division of Northern Ordnance, Inc., from 1943 to 1946. After maintaining a general consulting practice for one year in Tulsa, Bednar joined Meyer and Achtschin in 1947—becoming a full partner in 1949.

R. E. McAdams

R. W. Bond

Shell Oil Company designated two new vice presidents. **R. E. McAdams,** exploration manager, was named vice president, exploration; he will continue to have general responsibility for the handling of exploration and land matters. **R. W. Bond,** production manager, was named vice president in charge of the Tulsa Exploration and Production area. Bond will succeed **C. P. Bristol,** vice president in charge of the Tulsa area, who will become vice president of the Midland, Texas, area. **J. E. Clark,** now vice president in Midland, will move to New York as vice president-production, replacing Bond. McAdams joined Shell as a geologist in 1936 at Shreveport, La. Bond began his career with Shell in 1925 as an equipment engineer at Tonkawa, Okla.

•

J. R. Sanders has been promoted to regional geologist for **Continental Oil Company's** Rocky Mountain region. Formerly assistant regional geologist, Sanders will continue to make his headquarters at Denver and will succeed **Dr. Bruce F. Curtis,** who has resigned to become an associate professor of geology at the University of Colorado. Sanders joined Conoco in 1945 at Lafayette, La.

•

Frank J. Hortig, until recently assistant executive officer of the **California State Lands Commission,** has been named chief executive officer.

•

John R. Suman, of Houston, former vice president and director of the Humble Oil & Refining Co. and of the Standard Oil Company of New Jersey, will receive the John Fritz Medal from the American Institute of Mining, Metallurgical and Petroleum Engineers. Suman is a former president and an honorary member of AIME. The Medal will be presented at the annual banquet of AIME the evening of Feb. 19, 1958, during its national convention in New York. In 1943 he received the Anthony F. Lucas Gold Medal awarded by AIME for "distinguished achievement in improving the technique and practice of finding and producing petroleum."

•

Robert Barwick has joined the geological staff of **New York State Natural Gas Corporation** in Pittsburgh, Penn. Barwick was formerly state geologist at the Pennsylvania Department of Forests and Waters, in Harrisburg, Penn. He was replaced by **Hugh Montgomery,** new state geologist.

•

The Field Drilling Company announced that **Robert A. Buschman** has replaced **Field Davis** as vice president and general manager, and that **Tom Neal,** formerly with Dillard & Waltermire, Inc., has replaced **Joe Bates** as field superintendent.

•

White Eagle Oil Company has announced the election of two vice presidents and the appointment of an assistant to the presi-

BRITISH MADE H/E 300 P.A. TRACTOR DRILLMASTER

MULTI-PURPOSE · HIGHLY MOBILE

The Hands-England 300 P. A. Drillmaster Rotary Drill is now available mounted on a Fordson Major Industrial Tractor and is illustrated on left.

This design provides great manoeuvreability and is intended primarily to enable the well known H/E Drillmaster 300 P. A. Rotary Drill to be used for Quarry and Open Cast blast hole, shot hole, auger, core or sample drilling.

Although the H/E Drillmaster 300 P. A. mounted on a diesel engined agricultural tractor, is ideal for Quarry and Open/Cast operations, it is equally applicable to some difficult "off the road" locations, such as may be encountered during seismic exploration or shot hole drilling.

In areas where a light drill with high tractive effort and good manoeuvreability is required, the H/E Tractor Drillmaster will be found to have much advantage over the conventional type of truck mounted drill.

Standard equipment provides for drilling holes of 2⅜" to 4" in diameter or to ream out 2⅜" diameter holes to larger sizes. Extra equipment can be supplied for cutting larger holes up to 5⅝" diameter, if desired.

For flushing cuttings to the surface an air compressor can be mounted directly onto the H/E Tractor Drillmaster and driven by the Tractor Engine. The compressor can achieve an up-hole annular velocity of 3,000 ft. per min.—using 'B' rod and 3" dia. bits. If air drilling is to be employed for larger holes, or where mud circulation is necessary, the equipment for these operations must be mounted on a separate trailer or tractor.

The H/E Tractor Drillmaster will be found to cover the majority of drilling requirements of the Quarry and Open Cast operator, the Geologist, the Mineralogist, and the Geophysicist.

Write for illustrated folders giving full details and specifications of this equipment.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD

MANUFACTURERS OF GEOPHYSICAL SUPPLIES

LETCHWORTH HERTS ENGLAND TEL: 600 CABLES: OIL LETCHWORTH ENGLAND

Exclusive licensees in Western Germany: August Goettker Flachbohrungen, 20a Wathlingen Kreis Celle, West Germany

dent. **Lee Daniel** was elected vice president in charge of drilling and **Robert Wm. Haigh** was elected financial vice president. Daniel has served the company as vice president of Helmerich & Payne, Inc., a wholly owned subsidiary engaged in contract drilling operations. He will continue to hold that office in addition to serving as vice president of Helmerich & Payne, C. A., a Venezuelan subsidiary. Reporting to Daniel from Venezuela is **Charles DeLay,** the recently appointed general manager of that company. Haigh joined White Eagle 18 months ago. Named to the post of assistant to the president was **Daniel R. Toll,** previously serving as executive assistant. Toll also functions as vice president of Engineering-Construction Co., a subsidiary engaged in pipe line construction.

•

Shell Oil Company announced two new district geological offices to be located in Durango, Colo. **J. E. Holzman** will head a new Durango district office. **E. G. Hoskins** has been named district geologist for the new Farmington, N. M., district. The Shell Durango district will handle the Western New Mexico and Southern Arizona area. The new Farmington district will handle exploration activities for Northern Arizona, Southeastern Utah and Southwestern Colorado. Holzman, until his appointment as Durango district geologist, was a geologist for Shell in Los Angeles. Holzman joined the Shell organization in 1950. The new Farmington district geologist, Hoskins, has been with Shell since 1949. He was formerly a geologist for Shell in Bakersfield, Calif.

DEATHS

Henry C. Cortes, 65, vice president and a director of Magnolia Petroleum Company, died December 6 in Honolulu, Hawaii, while en route to Taipei, Formosa. His retirement was to have gone in effect Jan. 1, 1958. Cortes began his career in 1924 with Vacuum Oil Company.

William H. Pinckard, 63, retired board chairman of California Texas Oil Co., Ltd., New York, died in Palo Alto, Calif., October 20. He had retired in April after 40 years in the oil industry. He started his career with The Texas Company in 1917 and spent more than 20 years in the Far East and other foreign posts. In 1936 he participated in the formation of the Caltex group owned jointly by Texaco and Standard Oil Co. of California.

Frank Charles Wiest, 60, geologist with the Springer Interests, died October 5.

Roy Yarrington, 67, oil company field superintendent, died October 7 in a Galveston, Texas, hospital. He was employed by Stewart Petroleum Co. for the past ten years.

Russell Clyde Barbour, 31, a district petroleum engineer for Humble Oil & Refining Company, died October 7 in a San Antonio, Texas, hospital.

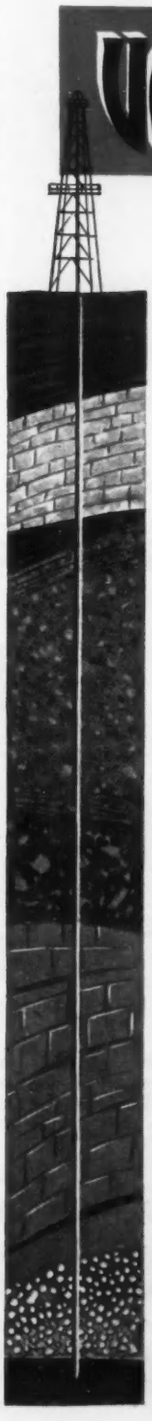
Hugh L. (Pert) Sargent, vice president, oil tool sales, Sargent Engineering Corporation, died November 21 in Pittsburgh, Penn. He directed the activities of 21 Sargent production supply stores throughout the country.

Albert R. Jones, developer of large Mid-Continent oil and gas fields, died November 21. His career included the presidency of such oil developments firms as the Mission Oil Co., the Lotus Oil Co., the Trojan Oil Co. and the A. R. Jones Oil and Operating Co.

Harold L. Strader, who headed Harold L. Strader Drilling Company, Houston, died August 2. Strader's firm was the first to drill offshore in Canada with rotary tools, in Lake St. Clair.

W. C. Stevenson, 58, Union Oil Company of California vice president for industrial relations, died October 21 at La Jolla, Calif. In 1946 he was made assistant to the vice president and in 1952 elected vice president in charge of industrial relations.

Walter C. Nelson, 72, oil producer in San Antonio, Texas, died in his apartment in San Antonio, October 26. Nelson was a pioneer in the oil business, starting at Spindletop in 1902.

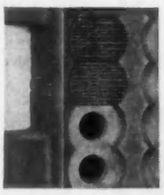


VARCO

Type SRL-Long Rotary Slips Provide the—Long Life—Safety—Low Maintenance Costs Needed for the Deepest Drilling!

Type SRS — Short Rotary Slips Available for Shallow to Medium Drilling

VARCO type SRL-Long Rotary Slips are especially designed, carefully manufactured and the most modern controlled heat treatments are employed to produce highest quality performance. They have the greatest amount of line contact per weight and equal size of any Rotary slips. Their advanced design combines light weight with high ultimate strength to provide the greatest possible protection for deep drilling.



FIRM HOUSING OF BUTTONS IN INDIVIDUAL COUNTERBORES integral to the slip body prevents wear and danger of elements falling into the hole.

SHALLOW TOOTH BUTTONS reduce penetration to the minimum. The gripping element renders maximum line contact.

Only VARCO Rotary Slips incorporate all these advanced principles.

1. Shallow tooth gripping element with maximum line contact and minimum penetration. **2.** All gripping elements individually, firmly and safely housed in counterbored slip bodies. **3.** Self-aligning hinge blocks. **4.** Forged and heat treated alloy steel handles. **5.** Maximum strength. **6.** All component parts of VARCO Rotary Slips are made from selected alloy steel and they are subjected to multiple heat treat operations to obtain maximum strength and toughness.

See Our Section in The Composite Catalog or . . .

Write for new catalog!

Abegg and Reinhold Co.

HOUSTON, TEXAS - OKLAHOMA CITY, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

Catawissa
PERFECT SEAL
Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!

Standard & Double Extra Heavy
UNIONS

Available with screwed or socket weld ends. 3000-lb. sizes 1/8" to 3"; 6000-lb. sizes 1/8" to 2".

ORIFICE UNIONS

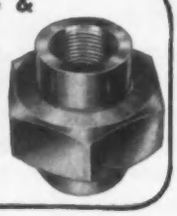
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS

With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS

With screwed or socket weld ends. 3000-lb. and 8000-lb. service.



WRITE FOR CATALOG 56
showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
60 Mill Street • CATAWISSA, PA.

COMPANIES in the News

AMERICAN TRADING AND PRODUCTION CORPORATION has purchased producing oil properties in the Gladiola field of Lea County, New Mexico, from Texas Crude Oil Company of Fort Worth. The properties acquired by American Trading, for an unreported consideration, consists of the entire interest of Texas Crude in five 12,000-foot Devonian wells in the field, with net reserves estimated in excess of one-half millon barrels of oil.

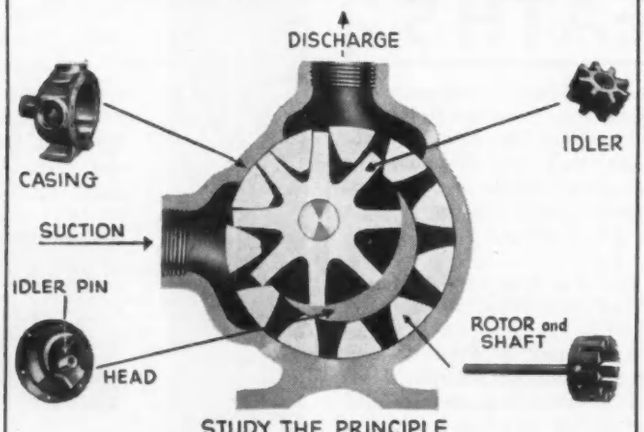
•

THE TEXAS COMPANY announced the formation of a new department, the Foreign Producing department, Western Hemisphere and West Africa, with **A. W. Baucum** as general manager. President **James W. Foley** said that "this consolidates into a single department the responsibility for all of Texaco's exploration and producing interests in Canada, Latin America and West Africa." Baucum started work for Texaco in the Domestic Producing department in 1934. He was named assistant to the president of the company in 1954. He had been general manager of the Foreign Operations department since 1956.

•

STANDARD OIL COMPANY OF CALIFORNIA, WESTERN OPERATIONS, INC., has awarded a contract for fabrication of the state's first offshore oil drilling platform to National Steel and Shipbuilding Company of San Diego. The contracts totals approximately $750,000 for the basic platform only. Contracts for superstructure and all other equipment will be announced at a later date as soon as negotiations with other construction and supply firms are completed. The platform is scheduled for completion in May of 1958 and should be towed to the drilling site on the Standard-Humble lease at Summerland, Calif., near Santa Barbara,

Viking Operating Principle



STUDY THE PRINCIPLE

Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

Distributors

SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS
Service Facilities at: Houston–Dallas–Kilgore–San Antonio–Edinburg
Corpus Christi and Beaumont, Texas

Calif., later in the summer. The two companies share equally in the lease with Standard acting as operator. When it is completed and on site, the new platform will be capable of drilling 25 wells, two at a time. Total cost of the installation has been estimated at more than two million dollars.

•

ETHYL CORPORATION has awarded 19 graduate research fellowships and five undergraduate scholarships at 24 leading colleges and universities. Total value of Ethyl's fellowship-scholarship grants is $50,000. The company scholarships, designed to supplement the student's own resources, pay up to $800 at tax-supported institutions and up to $1200 at private institutions. Most of the fellowships carry a stipend of $1500 for living expenses plus an allowance for tuition and fees. In addition, the university department concerned receives $500 for expenses in connection with the fellow's research work.

•

CONTINENTAL OIL COMPANY has completed in Ponca City, Okla., its atomic radiation laboratory, which will utilize nuclear radiation in experiments designed to create or improve petroleum and petrochemical products and processes. The nuclear radiation used for studies at the new unit is being supplied by fuel elements in ten-pound uranium cylinders or rods shipped to Ponca City from the Atomic Energy Commission's plant and atomic reactors at Arco, Idaho. Four two-foot uranium rods have arrived at the Ponca City laboratory and are now in use. The rods are expected to last about four to six months.

•

THE PURE OIL COMPANY announced the moving of its Rocky Mountain Producing division headquarters from Billings, Mont., to Denver.

•

TEKOIL CORPORATION has made preliminary arrangements to purchase working interests in 72 oil wells and nonproducing royalties and leases covering 11,500 acres in Oklahoma and Kansas from Gerald L. Schlessman of Denver.

•

AMERICAN OIL COMPANY sent a newly "jumboized" T-2 tanker, re-named the "Amoco Virginia," out to sea recently for her formal trials. The Amoco Virginia, formerly the S. S. Hat Creek, is the third of four war-built T-2 tankers to undergo the jumboizing process at the Newport News Shipbuilding and Drydock Company in Newport News, Va. A fourth American Oil tanker will be similarly modernized next year. The jumboizing process, conceived and pioneered by Amoco, involves replacement of worn and corroded tank sections with a new and larger tank section to which the original bow, stern and midship house are attached. The result is a larger ship whose payload is greater by 35,000 barrels, from 140,000 barrels to 175,000.

SYMBOL OF SUPERIOR SERVICE

for electronic well logging, auxiliary services

IMPROVEMENT of existing field-proven equipment. Elgen's constant rigid testing program further develops services and tools to peak performance.

DEVELOPMENT of most modern, up-to-date electronic and nuclear logging tools and auxiliary services.

EXPERIMENTAL RESEARCH in TOMORROW's engineering TODAY . . . your assurance of maximum oil discovery with years-ahead technique development and tool design.

Write or call today. Elgen offices are in major oil areas to further serve you.

THE ELGEN CORPORATION
2925 MERRELL ROAD / DALLAS, TEXAS
FLeetwood 7-3958

For more data on advertised products, use Readers' Service Cards, last page.

what's Happening

among INDUSTRY ASSOCIATIONS

Sealey Is Honorary Member

Fred C. Sealey, newly-elected honorary member of the New York chapter of Nomads, is being congratulated by Maurice F. Delane, Jr., R. S. Stokvis & Sons, Inc., president of the New York chapter (left) and Herb E. Maland, R. J. Eiche & Associates, Inc.; regent.

Guests of Los Angeles

Guest speaker and foreign guests are shown at the Nov. 6, 1957, meeting of the Los Angeles chapter of Nomads. Left to right (standing) Doc Wilson of Fora France on his way to France; W. J. Williams of Aramco from Saudi Arabia; Hobart LaMar of D & E from Brazil; Clarence F. Anderson of Ralph M. Parsons Co., from Spain; Denton E. Fox of American Overseas Pet. Ltd. to Sumatra; Robert W. Braase of Aramco from Saudi Arabia; Basil Rose of Mene Grande to Venezuela; Edgar W. Carne of Baash-Ross Tool Company from Venezuela; E. T. Kempin of West Australian Petroleum from Australia; (seated) J. C. Bazinet of Petrobras to Brazil; George O'Neill of D & E from Arabia; E. L. Olsen of F.B.I., speaker of the evening; J. D. Rowe of Kellog Overseas to Sumatra.

Rocky Mountain AAPG Plans April Casper Meeting

The 1958 Rocky Mountain section meeting of the AAPG will be held in Casper, Wyo., April 27-30, it has been announced by John F. Partridge, Jr., general chairman of the 1958 convention. Selection of a later-than-usual date was necessary to avoid conflict with the National AAPG meeting in Los Angeles, March 10-13, and with a late Easter falling on April 13.

The 1958 convention sessions will be held in the new Industrial building at the Natrona County Fairgrounds, three miles from downtown Casper. The modern building seats 1500 persons and is equipped with the latest sound and projection facilities, as well as a lunch room and snack bar. Ample space for exhibits is provided in adjoining buildings. Outdoor space, either covered or open, is also available within a few steps of the Industrial building.

Pacific Section of AAPG Picks Grant as President

The following officers were elected by ballot to head the Pacific section of the American Association of Petroleum Geologists: president, U. S. Grant, IV; vice-president, Thomas A. Baldwin; secretary, George Y. Wheatley; treasurer, Robert R. Knapp.

Grant is professor for the Department of Geological Science at the University of California, Los Angeles; Baldwin is senior geologist for the Monterey Oil Company, Los Angeles; Wheatley is district geologist for the Superior Oil Company, Los Angeles, and Knapp is a geologist for the Standard Oil Company at Los Angeles.

Four Organizations Honor Turner With Hoover Medal

Scott Turner, former director of the United States Bureau of Mines, has been chosen by the representatives of four major national engineering organizations to receive their jointly-sponsored Hoover Medal for 1957.

Named after former President Herbert Hoover, who was its first recipient, in 1930, this gold medal is awarded "by engineers, to a fellow-engineer, for distinguished public service." The sponsors are the American Society of Civil Engineers; the American Institute of Mining, Metallurgical and Petroleum Engineers; The American Society of Mechanical Engineers; and the American Institute of Electrical Engineers.

Presentation will be in New York next February, at the annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Texas Mid-Continent O & G Elects Alcorn President

Charles W. Alcorn, Houston, executive vice president of Falcon Seaboard Drilling Co., has been elected president of the Texas Mid-Continent Oil and Gas Assn.

Alcorn was elected at the closing session of the group's meeting in Houston.

Alcorn formerly was an independent producer before joining T. N. Law in the formation of Falcon Seaboard in 1953.

Charles W. Alcorn

Nine Midwest Oil Men Receive Gold Certificates

Gold Award certificates for outstanding service in behalf of the Oil Information Committee of the American Petroleum Institute were presented to nine oil men from Kansas and Oklahoma at a meeting in Wagoner, Okla., of the Kansas and Oklahoma State Oil Information committees.

Recipients of the awards include: John Comstock, Welex Jet Services, Inc., community chairman at Stillwater, Okla.; Fred C. Fellingham, Pan American Petroleum Corporation, state chairman for the OIC in Oklahoma; Idan Flaa, Ethyl Corporation, chairman of the Petroleum Information Committee of the Tulsa Chamber of Commerce; D. M. Liles, Pan American, OIC state vice chairman for southwestern Kansas.

Also C. E. Muellerleile, Cities Service Oil Company, OIC state chairman for Kansas; L. T. Russell, Service Pipe Line

Company, OIC state vice chairman for south-central Oklahoma; Phil Sewell, Jr., Sewell Oil Company, community chairman for the OIC in Topeka, Kansas; L. H. Tomlinson, Socony Mobil Oil Company, state vice chairman in charge of the API school program. B. T. Willey, Continental Oil Company, district executive vice chairman for the OIC in the Kansas-Oklahoma district.

Otis Named First Recipient Of AIME's Carll Award

Herbert C. Otis, Sr., Dallas, chairman of the board of Otis Engineering Corp., Dallas, has been named as the first recipient of the John Franklin Carll Award for distinguished contributions to petroleum engineering. The award, a bronze plaque, was presented during the annual meeting of the Society of Petroleum Engineers of A.I.M.E. in Dallas recently.

Herbert C. Otis

The award was conceived "to recognize distinguished achievement in, or contributions to, petroleum engineering." It is sponsored by a senior member of the society.

Carll, whose name the award memorializes, was the first to express certain fundamental principles of reservoir mechanics which today are theorems used by petroleum engineers throughout the world.

AAODC Designates Heads For Fourteen Committees

Chairmen and vice chairmen of 14 national committees have been named by the American Association of Oilwell Drilling Contractors to serve during 1958.

Committee assignments are:

Accounting—chairman, H. Don Johnson, Carl B. King Drilling Co. of Texas; vice chairmen, F. E. Godfrey, Big Chief Drilling Co., and D. C. Anderson, Rowan Drilling Co., Inc.

Cable Tool—chairman, Ray Wiley, Ray Wiley Drilling Co.; vice chairman, Gail C. Culter, Culter Drilling Co., and Fred J. Spang, Spang & Co.

Chapter Activities—chairman, Don Slape, Don Slape Drilling Co.; vice chairmen, C. A. Norton, Norton Drilling Co.; and Harry J. Schafer, Jr., Schafer Drilling Co.

Drilling Contractors—chairman, Earle C. Hellums, Gracey-Hellums Corp.; vice chairman, T. W. Wheeler, Loffland Bros. Co., and M. G. Rowe, Rowan Drilling.

Education and Training—chairman, H. W. Davidson, Davidson Drilling Co.; vice chairmen, J. K. Kellogg, K. L. Kellogg & Sons, and J. J. Harrigan, Standard Drilling Co., Inc.

Insurance—chairman, David Kimbell, Alan Drilling Co.; vice chairmen, R. L. Manning, R. L. Manning Co., and Hunter Eakle, Eakle & Holder Drilling Co.

Membership and Dues—chairman, Herbert Woolf, Woolf and Magee, Inc.; vice chairmen, J. Geer Wilcox, Circle Drilling Co., Inc., and F. A. York, Miller & York.

Publications—chairman, George F. McQueen, McQueen and Stout Drilling Co.; vice chairmen, Gerald N. Eason, Fain-Porter Drilling Corp., and A. J. Heiser, Brown Drilling Co.

Public Relations—chairman, A. Earl White, Mustang Drilling Corp., vice chairmen, R. B. McCloy, Big X Drilling Co., and R. C. Tucker, Great Western Drilling Co.

Resolutions—chairman, Jack H. Abernathy, Big Chief Drilling; vice chairman, E. Dale Mount, Harry Bass Drilling Co.

Rotary Drilling—chairman, B. E. Groenewold, Exploration Drilling Co., vice chairmen, M. M. Brantly, Brantly Drilling Co., Inc., and H. J. Magner, Rowan Drilling.

Safety—chairman, John B. Holmes, Holmes Drilling Co.; vice chairmen, Austin W. Mosley, Southland Drilling Co., and H. R. Bean, McAlester Fuel Co.

Taxation—chairman, M. C. McBride, Camay Drilling Co.; vice chairmen, M. Clay Chiles, Chiles Drilling Co., and James G. Adkins, Adkins Drilling Co., Inc.

Transportation—chairman, N. H. Wheless, Jr., Wheless Drilling Co.; vice chairmen, C. E. Blount, Blount Drilling Co., and Carl T. Gates, Fowler Drilling Co.

NOW! KING
30, 40 and 50 KG
SWIVELS
With all the superior features of the King XV Series Swivels, the KG now provides
PACKING-BOX CHANGE
WITHOUT "BREAKING OUT."
New packing box arrangement eliminates necessity of removing gooseneck and bearing housing to change packing, thus eliminating thread-galling.
NEW!
• Washpipe-packing box arrangement permits higher-speed rotation.
• Oversize watercourse makes these swivels ideal for both conventional and reverse circulation methods.
• Zerk Fitting in stuffing box simplifies lubrication of Chevron or V-type packing.
For drilling relatively shallow oil wells, the deepest of water wells, workover rigs, slim hole drilling and "drilling in" and coring oil wells. Superior performance at 100 rpm to 6,200 feet with 2⅞", 3,800 feet with 4½" drill pipe.
Exceptional capacities combined with light weight for easy transporting.
Export: R. S. STOKVIS & SONS
17 Battery Place,
New York 4, N. Y.
KING OIL TOOLS
P. O. BOX 15146 • HOUSTON 20, TEXAS • ORchard 3-3421

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening

among SERVICE and SUPPLY MEN

Art Hawkins

Art Hawkins was appointed division manager for **H. C. Smith Oil Tool Co.** Hawkins will make his headquarters in Ventura, Calif. He joined the company in 1947 and in 1953 was appointed branch manager. Last June he was made assistant division manager.

•

John Feeser, sales manager for the **Brown Oil Tool Company,** attended the annual meeting of the Society of Petroleum Engineers (AIME) in Caracas, Venezuela, November 6-9. Brown sponsored a display at the exposition held in connection with the meeting. Cooperating with this project was the firm's representative in Venezuela, A-Z Export, S.A. Feeser remained in South America to tour various oil fields to study present and future problems in parallel string completions. He visited Trinidad and other South American countries to arrange other export representatives for those areas.

•

Charles C. Brush has been appointed chief field engineer of the Spang-Chalfant division of **The National Supply Company**. He succeeds **Howard G. Texter,** who retired. Brush started at the Spang-Chalfant plant at Ambridge, Penn., in 1925, and was made a field representative in Houston in 1933. He was transferred to the Field Engineering department in 1950 and has served as assistant chief field engineer since April, 1957. He will have his headquarters in the Dallas Federal Building, Dallas.

Charles C. Brush

•

Byron T. Knight was transferred to Woodward, Okla., as field representative of the Oil Well Supply division of **United States Steel Corporation.** Knight was employed by "Oilwell" in 1953 at Oklahoma City and later that year was transferred to Seminole, Okla., as store manager, the position he held prior to his present appointment. Prior to his employment with "Oilwell" Knight had over 20 years oil field sales experience.

•

Oil Country Equipment Co., Inc., announced that **W. B. Duncan** is now associated with the company in an executive sales capacity. He was with Houston Oil Company of Texas for more than 35 years. At the time of the purchase of Houston Oil by Atlantic Refining Co., he was manager of drilling and production. Duncan will have his headquarters at the Houston offices of Oil Country Equipment Company, Inc. This firm manufactures and distributes Pathfinder centralizers and hole bore wipers.

W. B. Duncan

•

McNamar Boiler and Tank Co. has announced the appointment of **M. C. (Mac) Bolin** as vice president of the Gas Compressor and Gas Products division of the firm. Bolin joined McNamar in 1946 as a salesman, was made sales manager and in 1953 was appointed manager of the Gas Compressor division, the position which he held prior to his recent appointment as vice president.

•

William L. Carwile, Jr., of Tulsa, vice-president of Welex Jet Services, Inc., announced his resignation to form a company of his own headquartered in Tulsa. Details will be announced at a later date. Carwile has been connected with Welex nine years, and previously active in the drilling and servicing business some 14 years.

•

Rockwell Manufacturing Company has promoted five sales officials to new sales management posts in Pittsburgh. The five —all of whom have been named assistants to **Herman Gottwald,** recently appointed assistant vice president and product manager—Nordstrom valves—include: **Thomas I. Stacy,** former Houston district sales manager, now assistant product manager—transmission line valve sales; **Richard E. Miller,** former gas sales supervisor in the New York district, now assistant product manager—valve lubricants and accessories; **Jack W. Harris,** former Houston senior sales engineer, now assistant product manager—refinery and chemical valve sales; **John R. Applegate,** former Chicago senior sales engineer most recently attached to the Detroit branch office, now assistant product manager—utilities valve sales. **Clyde H. Chronister,** former Tulsa senior sales engineer, now assistant product manager—production valve sales.

•

Conrad Murrell has been named vice-president and general manager of the newly organized **Fluid Power Controls, Inc.** Murrell has spent considerable time in design development work. With the Bettis Corporation he was engaged in experimental and field test programs on oil tool specialties. For the past five years he has been active in development work with Payne Manufacturing Company where he also served as plant manager.

Conrad Murrell

•

Jones & Laughlin Supply Division has announced six personnel changes within the firm's Field Sales division. **E. J. Pierson,** formerly a resident salesman at Perryton, Texas, has been transferred to Liberal, Kansas, to serve as salesman. **G. N. Brotherton** has been made resident salesman at Bunkie, La. He formerly was local store manager there. **S. J. Payne,** salesman, has been moved from Borger, Texas, to Liberal, Kansas. **W. M. Wilkinson, Jr.** has been promoted from storeman at Corpus Christi, Texas, to salesman at Freer, Texas. **H. B. Ham** has been transferred from Oklahoma City to serve as salesman at J&L's Odessa, Texas, store. **R. M. Sutter,** salesman, has been transferred from Odessa, Texas, to Oklahoma, City.

•

Thomas E. Turner has been appointed sales representative for **Leschen Wire Rope Division, H. K. Porter Company, Inc.** His territory will include Virginia, West Virginia and North Carolina. Prior to this appointment he was a sales representative for Esso Standard Oil Co. covering the State of Virginia.

•

Frank W. Jenks, formerly executive vice president, **International Harvester Company,** was elected president of the company. Jenks succeeds **Peter V. Moulder,** who retired as president and who also resigned from the board of directors. Jenks began his Harvester career as a clerk in the Richmond sales office in 1914. He was later appointed zone sales manager then assistant district manager at Atlanta,

Ga., and acting district manager at Birmingham, Ala. He came to the General office in Chicago in 1928, and in 1930 was appointed assistant regional sales manager. He became manager of the credit bureau in 1933, and in 1941 was appointed manager of the Credit and Collection department. He was elected vice president, merchandising services, in 1944, and elected executive vice president in 1956. He has been a member of the board since 1952.

•

Clessie L. Cummins has retired as honorary chairman of the board and as a director of **Cummins Engine Company, Inc.**, Columbus, Ind. Cummins founded the Company which bears his name in 1919 and was its president from 1919 to 1947. He served as chairman of the board from 1947-1951 and as honorary chairman of the board since that date. He has been a director of the company since its founding. In 1943, during World War II, he was director of diesel production, War Production Board.

•

John C. Jett has been named division sales representative in Pittsburgh for the Eastern division of **The National Supply Company.** He succeeded **William Van Vleet,** who retired. Jett joined the company in 1929 as a clerk in its Paintsville, Ky., store. He advanced to store manager in 1939, district manager for the State of Kentucky in 1941, and district manager for the Kentucky-West Virginia district in 1953.

•

Hans Taeger has been appointed European sales manager of **Twin Disc Clutch A.G.**, the foreign subsidiary responsible for export sales of Twin Disc Clutch Company and its associated companies outside the U. S. Prior to Taeger's new appointment, he held the position of assistant manager of export sales. In this capacity he acquired a broad technical and commercial knowledge relative to the foreign requirements for Twin Disc friction clutches, fluid couplings, three-stage and single-stage torque converters and marine gears. Taeger will headquarter at Twin Disc Clutch A.G.'s new technical branch office at Zurich, Switzerland.

Hans Taeger

•

Loffland Brothers Company announced the appointment of **J. D. Poe** as contract representative of the West Texas-New Mexico division, with offices in Midland, Texas. Poe has just returned from an extended vacation and succeeds **H. J. Shumate** who is being transferred to New York City as manager of foreign contracting. Previously, Poe has been division superintendent of the West Texas-New Mexico division for the past nine years. He began his employment with Loffland Brothers Company in 1929. **R. H. Tipton,** recently appointed acting superintendent of the division, now becomes superintendent in charge of all drilling operations in the West Texas-New Mexico division.

•

Wickwire Spencer Steel Division of the **Colorado Fuel and Iron Corporation** announced two appointments. **Ernest J. Bolduc** was named New England district sales manager, and **Charles P. Harlow** will be sales manager of the Hardware Products department. Bolduc, whose office will be located at the company's New England headquarters in Boston, Mass., has been associated with Wickwire Spencer Steel since 1920. Until his recent appointment, he was Coburn products sales manager. Earlier he traveled as a sales representative in the New England states. Harlow has been with Wickwire Spencer Steel since 1936. Prior to his recent appointment, he was assistant sales manager of the New England area. He will assume his new duties at the corporation's subsidiary, American Wire Fabric Corporation, Mt. Wolf, Penn.

•

Ray D. Goodnight has joined **Rector Well Equipment Co.** as sales representative. Goodnight will work out of the Pampa, Texas, warehouse. Prior to joining Rector, Goodnight, whose oil field experience dates back to 1937, was with Seismograph Service Corp., J & L Supply and Foster Testing Co.

•

Reilly Tar & Chemical Corporation, announced the promotion of **Nick V. Kostoff** to technical services representative. In this capacity, he will handle the chemical and petroleum technical service in the Southwestern district. For the past six years, Kostoff has served as plant chemist at Reilly's Granite City, Ill., plant, an experience that makes him well qualified for his new assignment.

•

Newton H. Ottinger, former division logging engineer for **McCullough Tool Company's** Mountain division, has been appointed sales manager for McCullough's Four Corners district. Prior to joining McCullough in 1955, Ottinger was senior geophysicist for Sinclair Oil and Gas Company, and prior to that, was employed by Schlumberger Well Surveying Corporation for 16 years, attaining the position of district manager of their Gulf Coast and Mid-Continent districts. He will make his headquarters in McCullough's Four Corners district office in Farmington, N. M., and will supervise sales in the portions of New Mexico, Arizona, Colorado and Utah which comprise the Four Corners district.

Tracey E. Smith

Jack A. Godwin

Tracey E. Smith has been appointed vice president and general manager of **National Tank Company, Ltd.**, replacing **Jack A. Godwin** who has returned to National Tank Company's headquarter offices in Tulsa. Smith joined National at their Pampa, Texas, branch in 1940. He was transferred to Odessa in 1946 as district engineer, and in 1948 was promoted to branch manager at Odessa. In 1950 he was transferred to Dallas as division engineer and in 1952 was returned to the Tulsa office as chief sales engineer. Smith is headquartered in Calgary. Godwin went to work for National in 1935, first in the Tulsa warehouse. He was made manager of the Canadian division in 1948; then returned to the Tulsa office. Godwin is now head of Inventory Control for the over 50 National offices and branches.

•

Tom Gilbert was appointed assistant sales manager of **Electro-Technical Labs,** a division of Mandrel Industries, Inc. Formerly with General Geophysical Co. in land and offshore operations, Gilbert came to Electro-Tech as a salesman-trainee and worked in various departments throughout the company. He will be in charge of all in-plant sales activities in addition to his other duties.

•

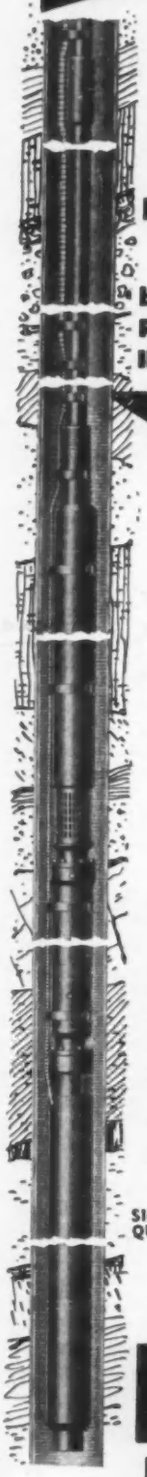
L. F. Drake has been appointed division manager of the Oklahoma division of **Welex Jet Services, Inc.** He will make his headquarters office in the company's division office in Tulsa. Drake was named to the new position after serving the past year as assistant sales manager of the company with his office in the general offices in Fort Worth. Prior to his assuming assistant sales manager duties, Drake had worked for a year as Fort Worth city sales engineer. He was transferred to Fort Worth in 1955 from Tulsa where he had been Oklahoma division sales engineer and had worked as sales engineer and assistant manager in the Ardmore district.

L. F. Drake

•

Mission Manufacturing Co. has announced six new sales division assignments. **Francis Hebert** has been appointed special sales

REDA PUMPS



FIRST CHOICE

FOR SECONDARY RECOVERY WATER FLOODING . . .

because pumping with REDA lowers costs and INCREASES PROFITS!

HERE'S HOW:

- Large water volume obtained from smaller size well casings reducing number of supply wells necessary
- Flexibility of Reda Pumps in meeting changing water requirements common to most waterflooding projects
- Easier, less expensive installation and lower maintenance costs
- Low operating costs and long operating life of Reda equipment
- Corrosion resistance of Reda pumps is superior to any other pumping unit used in supply wells

Reda Submergible Pumps are a major factor in the success of waterflooding and pressure maintenance operations. They are being used in major floods with very successful results of increased production and lowered costs.

Write for complete information today! Reda engineers will be pleased to call and assist in planning operations.

SIGN OF QUALITY . . SUBMERGIBLE REDA PUMPS

REDA

PUMP COMPANY

BARTLESVILLE, OKLA.

representative, Valve division, for the South Louisiana district with headquarters in Lafayette, La. Formerly, he was field sales representative in the Southwest Texas district with offices in Corpus Christi, Texas. **Jason Curtis** replaces Hebert in Corpus Christi as field sales representative. Named special sales representative in the Valve division for the West Texas-New Mexico district is **E. D. (Dean) Hallum.** His headquarters are in Midland-Odessa. He was formerly field sales representative in the West Texas-New Mexico district, officing in Odessa. Replacing Hallum as field sales representative in the Odessa territory is **R. E. (Jack) Hardy.** Hardy was formerly field sales representative in Andrews, Texas. Hardy has been replaced in the Andrews territory by **Joe Weaver. Robert L. Rooth** has been named field sales representative for the Ark-La-Tex district with headquarters in Shreveport.

•

Joseph F. Wright has been appointed senior engineer in charge of engineering test facilities for **Cameron Iron Works, Inc.** In 1937 he was employed as a junior engineer by the Weirton Steel Company, Weirton, W. Va. In 1942 Wright became the chief engineer of the New Castle Defense Plant, New Castle, Del., which produced shells for both the Army and Navy. From 1944 to 1947 he was chief project engineer in the Ordnance Research and Development division of the Rheem Manufacturing Company in Baltimore. After the war Wright accepted the position of assistant to the vice president of the H. Belfield Company. Wright joined Cameron in August, 1955, as an application engineer and until this appointment has been in charge of field testing Cameron's valve products.

Joseph F. Wright

•

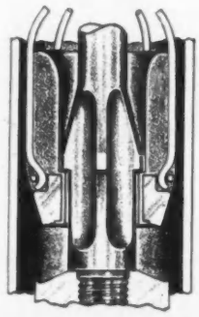
Earl H. Anderson has been appointed to the position of assistant to the works manager by **Edward Valves, Inc.,** subsidiary of Rockwell Manufacturing Company. Anderson's recent manufacturing experience includes service as works manager of Milwaukee Valve Company and plant manager of Carver Pump Company. Earlier he held positions as plant superintendent for Harry Ferguson, Inc., tractor manufacturers, and industrial engineer and general foreman with Aluminum Company of America.

•

George W. Morte has been promoted to district manager of hydraulic sales and service for the **Axelson Manufacturing Co.,** division of U. S. Industries, Inc. His area will cover the Permian Basin and Louisiana. Morte was previously district sales manager for Axelson, and prior to that

FIRST REAL SWAB ADVANCEMENT IN YEARS

The development of the Oil States mandrel and swab cups has given the industry one of the *greatest swabs ever to hit the market.* Operators everywhere find the Oil States Swab Cups last longer and pull a bigger load. They say they can really make money with an Oil States Swab.



Cup position when going into hole.

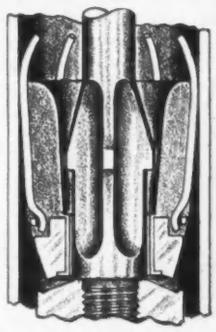
Fig. 1

OIL STATES SWAB CUPS

The free pivoting wire, as shown in Figs. 1 and 2, allows the cup to respond to the lightest loads and, at the same time, lift the heaviest loads — NO BENDING OF WIRES REQUIRED!

Cup position when coming out of hole under load.

Fig. 2



OPERATORS EVERYWHERE ARE SWITCHING TO OIL STATES SWABS

Oil States

OIL STATES RUBBER CO.

ARLINGTON, TEXAS

was with the Vickers Manufacturing Company. He will be located at the Axelson offices and Hydraulic Pumping Unit center in Odessa, Texas.

Oscar Bernardes

Klaus Wolf

Web Wilson Export Men Receive Training Courses in Los Angeles

Recent visitors to the Los Angeles general offices and factory of Web Wilson Oil Tools, Inc., were Oscar Bernardes of Equipan, Equipamentos Gerais, Ltda., of Rio de Janeiro, Brazil, and Klaus Wolf of Fagro GmbH fur Erdol und Bergbau, Hannover, Western Germany.

Both received factory training courses in the manufacture and operation of Web Wilson Products for better service to operators in their respective areas.

Overseas Americans Formed For Foreign Construction

Overseas Americans Inc., is a newly formed organization of construction and engineering workers employed and interested only in overseas projects. The new group will act as a clearing house for collecting, analyzing and exchanging information concerning foreign construction and engineering projects under construction or proposed.

Headquarters are located at 7 West 44th Street, New York 36. Herbert U. Ross is president and C. Foster is secretary-treasurer.

Superbar Mud Sales, Inc. Formed in Lake Charles, La.

Formation of a new oil well drilling mud firm, Superbar Mud Sales, Inc., has been announced by the president, William L. Vincent.

The company has its headquarters at Lake Charles, La., and maintains warehouses and bulk plants at Lake Charles, Jennings and Crowley, La.

Principals in the organization, who are also the owners, are, in addition to Vincent: Seth Trammell, vice president, and Charles P. Hampton, vice president.

All of the owners are veterans of the oil well drilling mud field. Vincent has been active in the field of mud products and engineering for the last 15 years. Trammell has been associated with drilling mud distribution for 17 years, and Hampton has over eight years drilling mud experience.

Heading up the organization's Engineering department is Guy Richards. Sales coordinator is Richard B. Carlton.

According to Vincent, the firm plans to limit its service at present to southwest Louisiana. Its plans for the future are to expand eastward along the Louisiana Gulf Coast.

Hughes Tool Co. Increases Drilling Research Program

Hughes Tool Company has announced the stepping up of its drilling research program in Houston. When a new steel and masonry addition to the block-long Hughes engineering and research laboratory is completed, working area will have been increased by about 50 percent.

Although the present laboratory was completed only five years ago, steadily increasing volume of research has made more space necessary. The new addition is the sixth major increase of Hughes' research facilities.

Halliburton's Annual Report Judged First Among Industry

The best 1956 annual report among oil well supply companies was produced by Halliburton Oil Well Cementing Co., a national judging team has announced.

Logan D. Campbell, Halliburton's chairman, and John P. Harbin, controller, were presented a bronze "Oscar of Industry" for the company's 1956 annual report

Get more footage at lower cost with

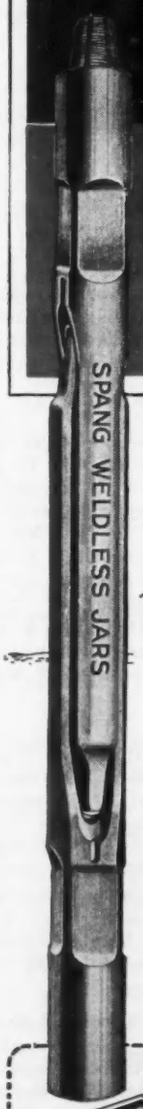
SPANG

ALLOY-STEEL

Weldless Jars

...forged from ONE PIECE of Alloy Steel

NO WELDS TO BREAK . . .



Each SPANG WELDLESS JAR is forged from a single piece of selected alloy steel and is scientifically heat-treated and tempered to obtain proper hardness and toughness in the rein sections for maximum strength and wear resistance in the most severe drilling service.

The joints, heat-treated and precision machined, are stronger and more durable, assuring fewer fishing jobs. Records over the years show up to four times more footage with SPANG Alloy-Steel WELDLESS JARS.

For further information on weldless jars, and for FREE CATALOG of other SPANG cable tools, contact your nearest Dealer or write direct to:

The HIGHER STANDARD

SPANG & COMPANY

DEPT. 0-6 BUTLER, PENNSYLVANIA

For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

For more data on advertised products, use Readers' Service Cards, last page.

at a banquet in New York City attended by business and financial leaders from the U. S., Canada and Latin America.

Harbin produced the report, which was one of 5000 submitted for appraisal to a judging team headed by the dean of the graduate school of business administration of New York University; the managing director of the Controllers Institute of America; the art director of Pratt Institute; and the former president of the National Federation of Financial Analysts Societies.

Runner-up to the Halliburton annual report in the oil well supply category was Dresser Industries, Inc. Third place was given the National Supply Co.

The contest is sponsored by **Financial World** magazine.

Ralph Enloe to Manage New Bovaird Shreveport Store

Ralph Enloe has been appointed manager of the new Bovaird Supply Company store at Shreveport, La.

Ralph Enloe

Enloe has been in the oil field supply business for 15 years.

This Bovaird store, serving the drilling and production operations of the Ark-La-Tex area, is located at 149 Thomas Drive. A new building has been acquired, stocked and manned to distribute a complete line of equipment to the petroleum industry.

Shaffer Corporation Formed for Western Hemisphere Work

Shaffer Tool Works has announced formation of a new corporation to be known as Shaffer Western Hemisphere, Inc.

The new corporation was organized to facilitate Shaffer operations in the various oil and gas countries of the Western Hemisphere. The first division of the new corporation will be a Canadian division in Edmonton, Alberta. John T. Monks, Jr., is manager.

Engineers Taught Valve Care As Part of Rockwell Program

A course on valve care and maintenance completed at Phillips Petroleum Company, Borger, Texas, marks the beginning of an intensified nationwide educational program in this field being launched by Rockwell Manufacturing Company.

More than 300 Phillips valve repair men, pipe fitters, engineers and operators were briefed by top Rockwell engineers and sales personnel. The course consisted of a series of ten three-hour meetings held in Borger and Guymon, Texas. The course itself and the 180-page instruction manual were designed especially for personnel of chemical plants, refineries, gasoline and carbon black plants and production and engineering departments.

Magcobar Buys Ready-Made Lab From U. S. Bureau of Mines

Magnet Cove Barium Corporation, Houston, one of the Dresser Industries, has purchased a mineral dressing research laboratory and plant at Bauxite, Ark., from the U. S. Bureau of Mines.

Magcobar was the highest bidder on the plant, which was recently put up for sale after being declared surplus by the federal government. It was originally constructed during World War II.

It will use the plant to conduct research on the commercial uses of selected minerals. Purposes of the research will be the improvement of the metallurigcal processes at Macobar's existing facilities and the development of new products as part of its continuing expansion program. Dresser Industries will also use the plant for research.

The laboratory and plant are equipped with facilities for mineral dressing research on almost every type of ore beneficiation.

Two Texas Logging Units Opened by Schlumberger

The opening of two new logging units at Woodard, Okla., and Freer, Texas, has been announced by the Schlumberger Well Surveying Corporation. The additions will facilitate service in the vicinity of these two towns.

●

Houston Oil Field Material Company, Inc., announced the appointment of **C. J. Erwin** as export manager and **H. D. (Bob) Robinson** as assistant export manager. Both men will be located in New York. Erwin has been with Homco since 1944. He leaves the position of division manager of services for Louisiana and Mississippi, where he was stationed in New Orleans. Robinson has been with Homco since 1946. He leaves the position of resident manager at Tulsa.

●

McCullough Tool Company has announced the transfer of Branch Manager **William Newashe, Jr.,** from McCullough's Kimball, Neb., service branch to the Rock Springs/Big Piney area in Wyoming. Newashe will make his headquarters at the Big Piney service branch. Newashe, who joined McCullough in 1949 will be in charge of operations at both the Rock Springs and Big Piney service branches.

●

Jimmie H. Goss has been appointed division sales representative in Toledo for the Eastern division of **The National Supply Company.** He succeeds **David E. Bayer,** who is now assistant district manager at Charleston, W. Va. Goss joined the company in 1951, serving at the Salem and McLeansboro, Ill., stores. He was transferred to Olney, Ill., in 1952, and has been district sales representative there since 1955.

J. A. Getty

W. J. Whitaker

W. C. Norris Manufacturer, Division of Dover Corporation, Tulsa, announced the creation of two new sales divisions in their sales organization. **J. A. Getty,** former district representative at Shreveport, La., has been transferred to Tulsa to head the new Central division. Under his supervision, as division manager, are the Kilgore, Texas; Oklahoma City; and Great Bend, Kansas; branches. The Tulsa City Sales staff will likewise operate under his direction. **W. J. Whitaker** has been made division manager for the North and West Texas areas, with division offices in Fort Worth, Texas. The Odessa and Wichita Falls branches are under his direct supervision in sales. The Gulf Coast division continues to operate under the direction of **C. L. (Les) Snelling,** division manager, Houston, with Houston and Corpus Christi branches under this office.

C. L. Snelling

●

Mahlon P. Brocklehurst and **Lloyd B. Harris** have been assigned as sales representatives to **Allis-Chalmers** San Diego, Calif., and El Paso, Texas, offices, respectively. Brocklehurst will handle industrial sales at San Diego. Harris will concentrate on general purpose equipment sales at El Paso.

●

Robert W. Olson was appointed vice president-research and engineering of **Texas Instruments Incorporated,** and **E. O. Vetter** as general manager of TI's Industrial Instrumentation division at Houston. Olson, a vice president of TI from 1951 to 1953, returns to the executive staff after serving nearly four years as head of the Industrial Instrumentation division. In his new position, Olson will direct the planning and coordination of TI's research and engineering activities, especially on the long-range basis. Vetter goes to his new position from Geophysical Services Inc., a TI subsidiary company, where he had served as administrative vice president since 1955.

●

M. W. Hartman has been named sales manager of the Darcova division by **Darling Valve & Manufacturing Company.** This is a newly created post for the sale of Darcova valve cups, seating cups, seating rings and Pumcups. Hartman has been with the company as district sales engineer in the Mid-West area since 1946.

WORLD OIL'S Trading Post
CLASSIFIED ADVERTISING

RATES: **Regular Classified** (undisplayed) set in this size type: 20 cents per word. Minimum charge $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance.** Send copy and checks to: Trading Post Classified Section. World Oil, P. O. Box 2608, Houston, Texas.

BUSINESS OPPORTUNITY

OIL CONCESSION BUSINESS WITH A FUTURE

THIS WILL APPEAL ONLY TO PEOPLE WHO ARE INTERESTED IN EXPLORATORY AND EXPLOITATION OIL CONCESSIONS INTERNATIONALLY. I HAVE BEEN IN THIS FIELD SINCE 1935 AND NEGOTIATED ONE OF THE WORLD'S LARGEST. AT PRESENT I HAVE THE POTENTIAL TO DELIVER ANOTHER OUTSTANDING CONCESSION WITHIN THE NEXT NINETY DAYS. THIS WILL BE ON TERMS THAT ARE SOUND AND WILL PERMIT THE EXPLORATORY GROUP TO MAKE SOME MONEY . . . . UNLIKE SOME OF THE PSYCHOPATHIC CONCESSION CONTRACTS THAT HAVE APPEARED LATELY. I DO NOT SEEK EXPLORATORY OR DRILLING MONEY. I HAVE MORE THAN ONE GROUP WITH SUFFICIENT FINANCE AND EXPERIENCE TO UNDERTAKE ANY OIL CONCESSION THAT I MIGHT ACQUIRE. I AM SEEKING A MAN OR GROUP THAT WILL GAMBLE ON MY EXPERIENCE AND INTERNATIONAL BACKGROUND TO THE EXTENT OF FINANCING A SMALL NEW YORK OFFICE AND MAINTAIN ME REASONABLY. THE WHOLE OPERATION WILL REQUIRE AN INVESTMENT OF $50,000, OVER A PERIOD OF TWELVE MONTHS ON THE BASIS OF A FIFTY PERCENT INTEREST IN MY COMPANY, WHICH IS A FULLY TAX PAID LIBERIAN CORPORATION. MY BOARD OF DIRECTORS CONSISTS OF SIX OUTSTANDING PERSONALITIES. I CONTROL THIS COMPANY AND CAN LEGALLY AND MORALLY DO WHAT I PROPOSE HEREIN. IF INTERESTED PLEASE WRITE BOX 147-W, WORLD OIL, Houston, Texas.

HELP WANTED

Reservoir Engineers

(Ages 27-38)

A major integrated U. S. oil company operating in Venezuela has outstanding career opportunities for qualified RESERVOIR ENGINEERS. Excellent growth possibilities are present in an expanding technical organization. Graduate engineers and physicists who have had FIVE to TEN years of specialized and general petroleum reservoir engineering experience are invited to submit a complete resume of work experience and personal data. Naturally, all replies will be held in confidence and interviews arranged for qualified candidates. Salary, including bonus, $14,900-$18,000, depending on qualifications and experience. Company is a leader in the petroleum industry with excellent employee benefits, including home vacations with travel expenses.

Box 480
Department Y-82
New York 19, N.Y.

SITUATIONS WANTED

■ GEOLOGIST—Exceptionally well qualified with 11 years diversified experience to direct small company exploration and production program in the Southwest, particularly Texas. Box 141-W, WORLD OIL, Houston, Texas.

FOR SALE

IMMEDIATE DELIVERY FROM STOCK
All Steel
New "Equity" 45' diesel tug
New "Equity" 55' diesel tug
New 110' x 30' x 6'5" Barge
Wire or phone today!
EQUITABLE EQUIPMENT CO., INC.
410 Camp Street New Orleans 12, La.

FOR SALE
One Beaird-Ingersoll-Rand Packaged Compressor Plant Type 8 JVG, Direct Connected, 4-Cycle, Single Stage Gas Compressor. This unit for practical purposes is in new condition. Complete specifications and price will be quoted to prospective purchaser.
Louisiana Nevada Transit Company
Ada, Oklahoma

FOR SALE: Model RL Cardwell spudder. Equipped to service 8000 foot wells. In excellent repair. Presently operating Ft. Morgan, Colorado area. Considerable company work will be given purchaser. Contact Lowell J. Williamson, 2150 South Bellaire, Denver, Colorado, SKyline 6-8333.

■ If you have Oil and/or Gas property that you would like to sell and the value does not run over 100 Million dollars, write H. S. Christian, Box 271, Tyler, Texas.

HELP WANTED

WANTED: Experienced accountant for aggressive, Denver based, independent oil firm. Must be able to assume office manager position. Excellent salary for top caliber man, send complete resume to Box 146-W, WORLD OIL, Houston, Texas.

WANTED: Geologist with top qualifications for top paying job with aggressive Denver independent, active in Colorado and Canada. Canadian experience desirable but not necessary. Send references and qualifications to Box 145-W, WORLD OIL, Houston, Texas.

BUSINESS SERVICE

■ **Delaware Corporations formed and serviced Inquire without obligation. American Guaranty & Trust Company, 910 West Street, Wilmington, Delaware.**

■ INCORPORATE in Nevada for oil and mining projects. Do business anywhere. Positively no liability of organizers and stockholders. Over 25 years experience. Financing assistance at no additional cost. Write for Resume. L. O. Goodman, L.L.B., Box 991 Globe, Arizona.

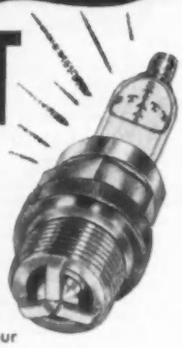
Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire or call collect for further information.

MAKIN DRILLING COMPANY
P. O. Box 1628
Hobbs, New Mexico
Phone: EXpress 3-3141

Here's the spark plug for CLARK® ENGINES

STITT

NEW TRIPLE IGNITORS



Clark is now factory-installing STITT new Triple Ignitor Spark Plugs in Turbo Charged engines . . . Bring your Clark engines up to date—repower them with STITTS which give you longer life, cut downtime, increase magneto life. STITTS are also factory equipment in Waukesha, Cooper-Bessemer, Worthington, other leading engines

Write today for FREE pocket booklet giving recommended plugs for all engines—you can get better plug performance.

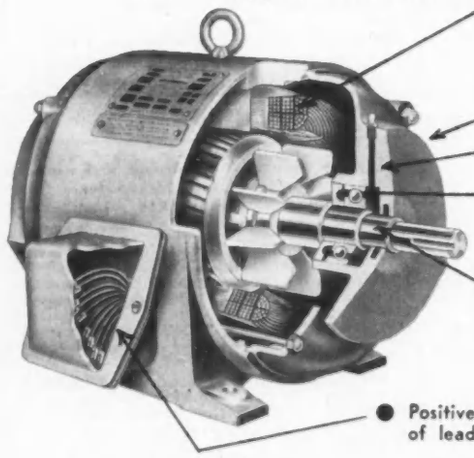
STITT IGNITION CO.
COLUMBUS 1, OHIO
STITT MAKES HEAVY-DUTY, INDUSTRIAL-TYPE PLUGS!

SQUEAKS from the BULLWHEEL

"Wildcatters"

STAMINA of BROOK A.C. MOTORS is no coincidence!

Design is based on over half a century of experience. Built to surpass NEMA Specifications, yet cost no more than ordinary motors. Single and polyphase. All major types. 1 to 600 HP. Shipped from stock.



- Long-life windings are triple impregnated and baked.
- Internally-ribbed, shock resistant iron frame.
- Generous bearing lubrication capacity.
- Bearings two sizes larger than customary; yet, still replaceable from any standard bearing stock.
- High tensile steel, precision ground shaft and balanced rotor assembly.
- Positive identification of leads.

SINCE 1904

world's most respected motor

BROOK MOTOR CORPORATION

3553 W. PETERSON AVE., CHICAGO 45, ILLINOIS

BROOK MOTOR CORPORATION

Factory Representative, Warehouses, Dealers, Service Stations, in Major Cities.

The Lion's Share

Jones and Smith were sitting in their tent in the African jungle discussing their skill as hunters. Presently Jones remarked that he would bet Smith a hundred dollars that he could go out and kill a lion forthwith. Smith took the bet and sat back to await results.

About an hour passed, then a lion put his head through the tent flap. "Do you know a fellow called Jones?" it asked.

"I do," said Smith, backing away.

"Ah," said the lion, "he owes you a hundred dollars."

The "Joy" of Parenthood

Trying to rest after an exceeding hard day at the office, poor father was being bedeviled by a stream of questions from

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 3-2167

Over 70 *Locations in the United States and Canada*

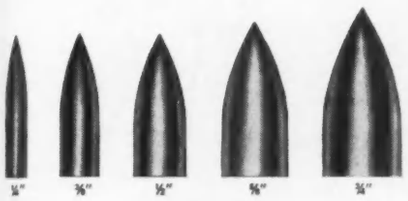
McCullough®
REPORTS
TO THE OIL INDUSTRY

Service *Anywhere Anytime*

New Services • • • New Tools • • • New Methods • • • Outstanding Results

McCullough Bullet Gun Proves Fracturing Power

M-3 Bullet Gun Assures Successful Completion of Fracturing Job...Penetrates and Cracks Tough Formation After Other Bullet Gun Failed



IMPROVED
McCULLOUGH OGIVAL BULLETS

Designed for maximum piercing ability, they are the deepest penetrating bullets known. Sizes shown above are standard. Burrless caps are available for all standard sizes. Special sizes and types can be furnished to meet unusual requirements.

Previously perforated with bullets by another service company, the operator was unable to fracture the formation in this Illinois well. Pump pressures to 4000 psi were reached without results.

McCullough was called to reperforate the well with the 4⅛" OD M-3 Bullet Gun. Twenty improved ½" Ogival Bullets were shot through 5½" 14 lb. J-55 cemented casing in a five foot interval from 2833' to 2838'.

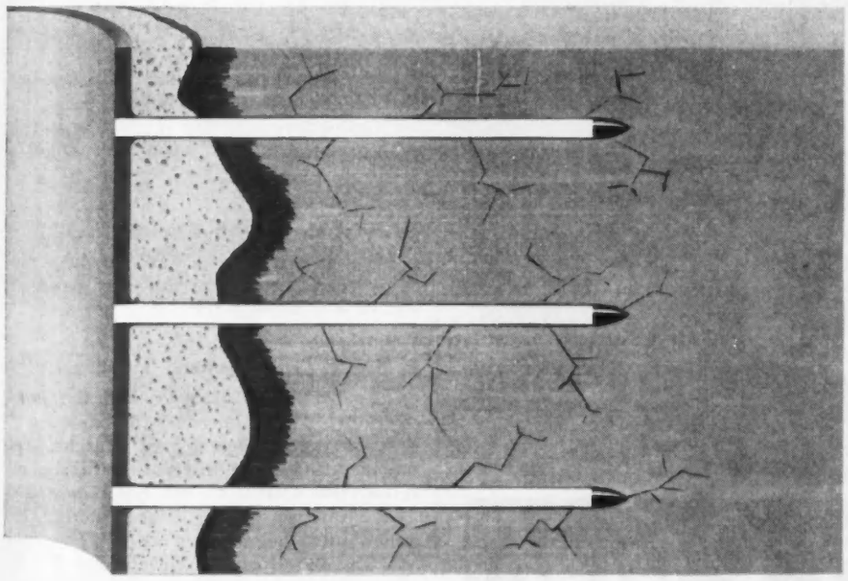
After perforating by McCullough, the formation broke down at 1600 psi and took fracturing material at the rate of 350 gallons of oil and 700 pounds of sand per minute. The well is now flowing—one of the best in the field—and entire perforating job required only 1½ hours rig time.

McCullough M-3 Bullet Guns and improved Ogival Bullets have always given you deeper penetration and superior formation fracturing ability. These features have proved invaluable where tough, tight formations must be further fractured under pressure for peak production.

And proof of this superior ability of M-3 Bullet Guns is in their long record of jobs successfully completed—after others have failed.

Next time, be sure of results—call McCullough first.

The job described above is certified by a true field report of services rendered.



M-3 BULLET GUNS GET DEEPEST PENETRATION
GREATER FRACTURING POWER

Size for size, McCullough M-3 Guns consistently outshoot all other bullet guns. They give you deepest penetration even through excessive thicknesses of casing and cement. They fracture the formation better than other bullet guns because they shoot harder. M-3's consistently get better results—peak production; more oil!

M-3 Bullet Guns have proved superior to other types of bullet and jet perforating under nearly all well and formation conditions encountered.

McCullough® *TOOL COMPANY*

Cable Address: MACTOOL

LOS ANGELES
HOUSTON
EDMONTON

little Willie, "What do you do down at the office?" Willie finally asked.

"Nothing," shouted the annoyed father.

After a thoughtful pause, Willie inquired, "Pop, how do you know when you're through?"

Lost Perspective

Radio Sound Effects Man: "I gotta have a horse to get the effects of knocking two coconut shells together."

No Time to Waste

After getting her divorce the actress paused on the courthouse steps before the assembled reporters. When one asked, "how do you feel?" she replied, "I feel like a new man."

Woman Driver to Friend

"Will you look how close that maniac is driving ahead of me."

Sure Cure

A widow who had married a widower was asked by a friend how it was working out. "I imagine," said the friend, "that he often talks about his first wife."

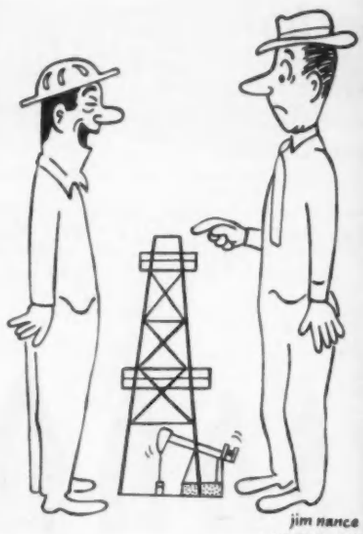
"He used to," said the other, "but I cured him of that. I started talking about my next husband."

Mooching In

Victims of an accident in Scotland were still lying on the road. Along came a native and said to a man lying on his back, "Has the insurance man been 'roon yet?"

"No," was the reply.

"Ah, weel, I'll just lie doon aside ye," said the Scot."



jim nance
WORLD OIL

"Oh, I'm just a small producer."

Green Fever

The doctor put down his instruments and looked severely at the patient.

"You're extremely run down," he stated.

"I prescribe less golf and a few more days spent in your office."

Why'd He Come Back?

I know a man who has convinced me of reincarnation. I'm sure that in some earlier life he was part of a horse.

If You'd Only Listen!

The drunk repeatedly called the hotel operator. "What time does the bar open?" She told him, "Eleven a.m." But he kept calling at frequent intervals until she referred the matter to the hotel manager. "Give me the 'phone," he ordered. He yelled into the mouth-piece, "We've told you the bar opens at eleven. But I'll be there, personally to see that you don't get in."

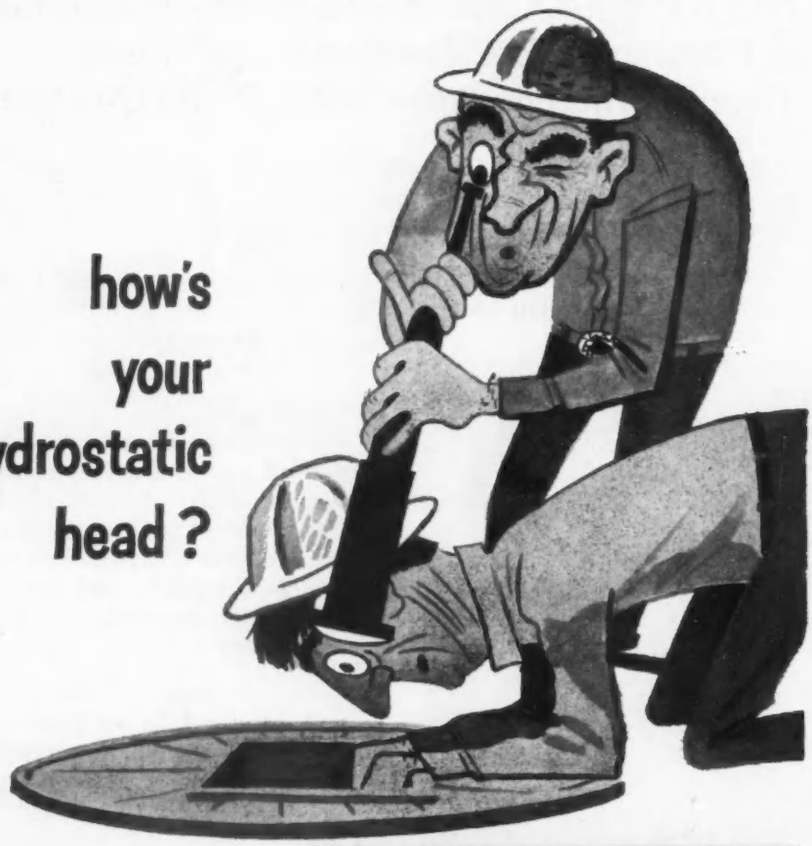
"Who wants to get in?" sneered the drunk. "I want to get out."

The Time to Part

The Lone Ranger and Tonto came upon a band of Indians, turned and started riding for their lives. Suddenly they came upon another band of Indians, and when the Lone Ranger asked "which way?" Tonto promptly said "this way" and they started for an opening in the hills.

Suddenly another band of Indians appeared in front of them, and the Lone Ranger asked "what do we do now?"

To which Tonto replied, "what do you mean 'we', white man?"



how's your hydrostatic head?

SEE WHAT'S HAPPENING DOWN THE HOLE WITH Pit-O-Graf

(Records mud pit level)

From the Pit-O-Graf chart you can calculate effectively any loss in hydrostatic head due to gas or salt water incursion. The continuous mud pit level chart warns of blowouts or threatened blowouts and loss of circulation.

WARREN AUTOMATIC TOOL CO.

Manufacturers of Mud-O-Graf and Rig Runner.

3915 Tharp St. Houston CApitol 4-2511

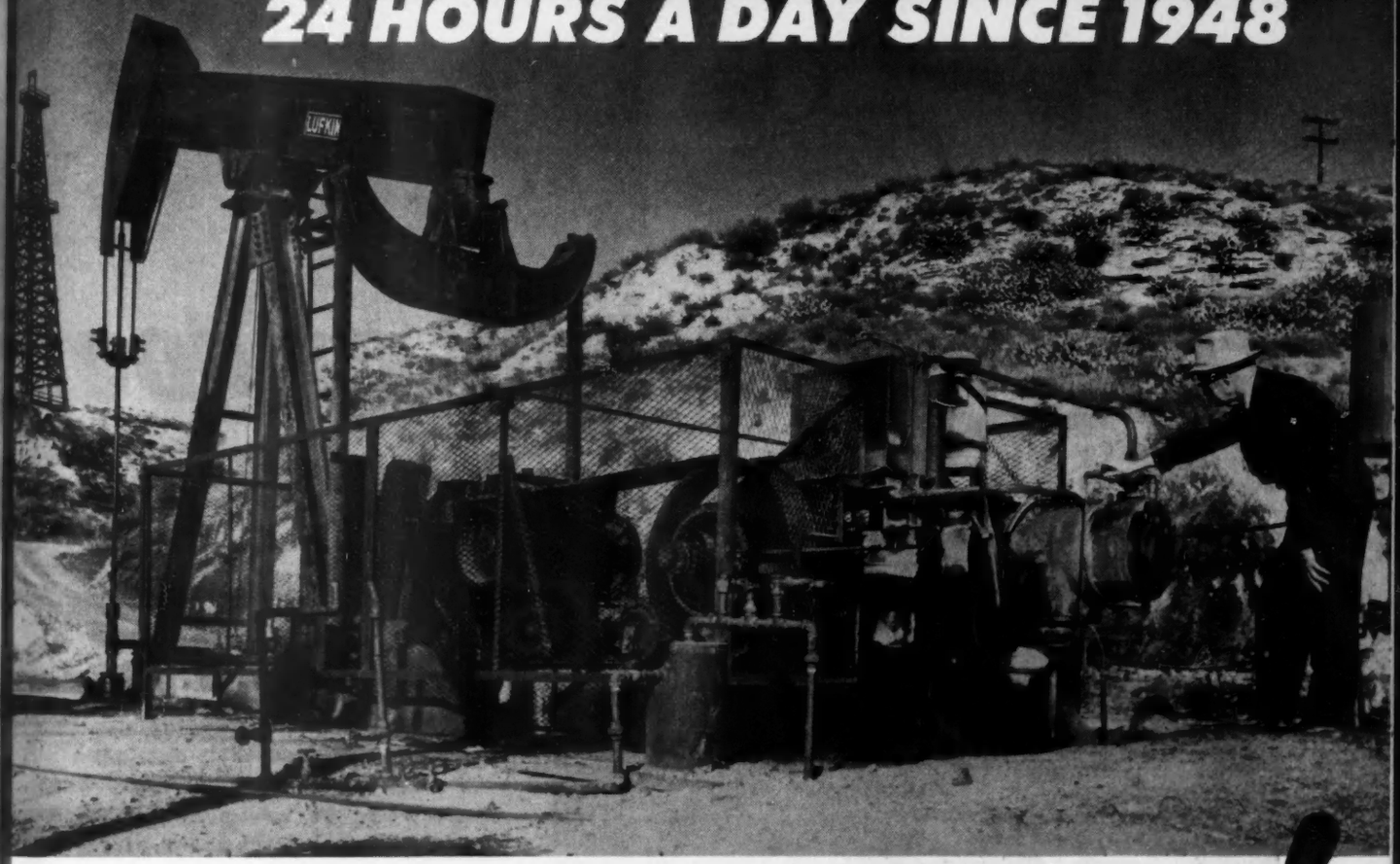
Lake Charles, La. HEmlock 6-2265

New Iberia, La. EMerson 9-9862

Harvey, La. FOrest 6-1441

for instance

This *Ajax* CM-11x14 has been running 24 HOURS A DAY SINCE 1948



UNUSUAL? NO—JUST *Ajax!*

This is a typical AJAX workhorse on the job . . . steady, faithful, productive, making a lifelong habit of continuous daily service. Since beginning operation in 1948, the cylinder head has never been removed from the engine. • The facts are, AJAX Gas Engines work for less for longer, and they ought to be working for you. Your Supply Man will be glad to help plan an Ajax program for your particular needs. Call him.

AJAX

GAS ENGINES

AJAX IRON WORKS CORRY, PENNSYLVANIA

Builders of **GAS AND OIL ENGINES, PRESSURE PUMPS, STEAM ENGINES**

Oil Field Distributors: **THE NATIONAL SUPPLY CO., PITTSBURGH, PA. • R. B. MOORE SUPPLY CO., BOLIVAR, N. Y. • BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA**

Management's attitude toward service is important. And the entire management of Stewart & Stevenson is concerned and working if your engine is down . . . concerned to the point that they will leave absolutely no stone unturned to get it back on the job in the shortest possible time.

"Engines are only as good a

Buying an engine is a big decision. And equally important is where you buy the engine. It is the cost of operating your engine in the long run (not first cost) that finally determines what you pay for it.

Any kind of engine . . . regardless of the conditions under which it operates . . . will need service someday. Then what? That's when the service attitude of the company you bought the engine from gets the acid test. More important, what happens to you? Down-time is expensive.

At Stewart & Stevenson, we look at engines and service from a realistic point of view. We recognize the fact that every engine is likely to need service. We know that an engine owner loses money every minute that his engine is not operating.

To serve you best, we have set up the largest distributor parts and service organization in the Nation. These facilities have stood the test of time and have actually saved engine owners thousands of dollars.

THE WORLD'S LARGEST DISTRIBUTOR O

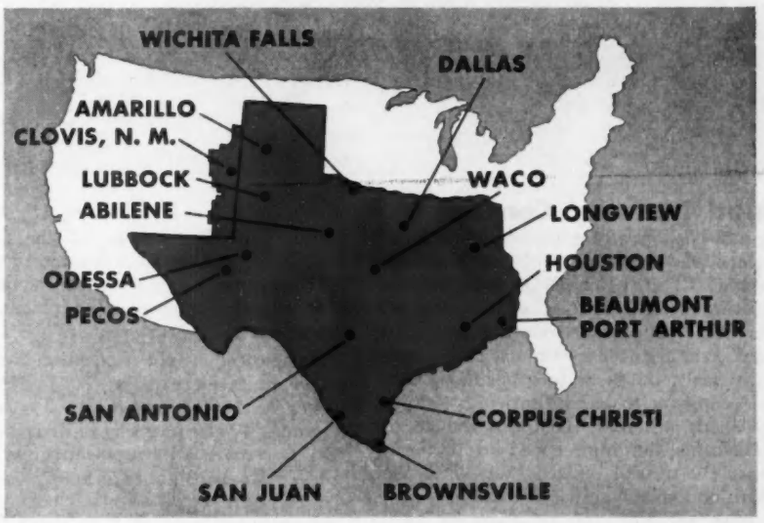
A STATEMENT OF FACTS AND POLICY FROM THE WORLD'S LARGEST DISTRIBUTOR OF DIESEL ENGINES

...as the service you get"

Every Stewart & Stevenson service man has a direct line to our management for on-the-spot decisions on replacements and warranties. There are no unlisted telephone numbers.

Stewart & Stevenson has become the world's largest distributor of diesel engines because of these facts: we assume full responsibility for your job . . . we guarantee it to perform as specified . . . we maintain the Nation's largest distributor stock of parts and 24-hour service usually not more than two hours from your installation . . . we have a backlog of experience gained through thousands of engine applications in practically every conceivable industry.

We believe that when you consider all these advantages . . . plus the Stewart & Stevenson management attitude toward service . . . you will agree that it's best to do business with an organization that will work as hard as you do to keep your engines operating at peak efficiency.



SYMBOL OF SERVICE
STEWART & STEVENSON
PROVED BY TIME

STEWART & STEVENSON SERVICES, INC.

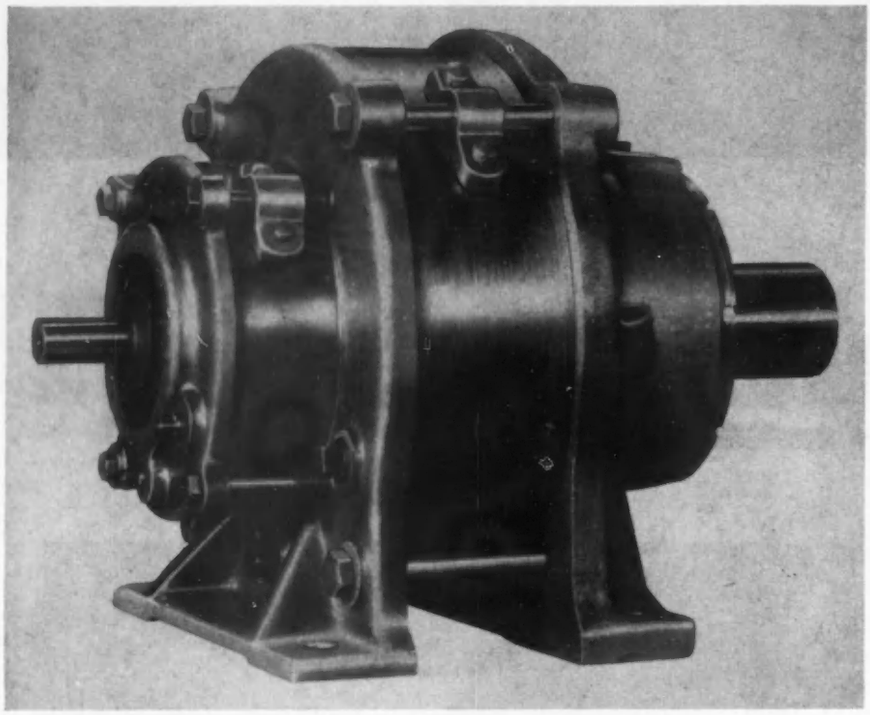
Main Office and Plant: 4516 Harrisburg Blvd., Houston 11, Texas.
Phone CApitol 5-5341

Export Office: Room 1405, 74 Trinity Place, New York, N. Y.

DIESEL ENGINES

What's New in EQUIPMENT and SERVICES

Drilling - Production - Exploration



Speed Reducer Concept

A new concept in the economics of speed reducers was announced by the Crichton Company. This principle is incorporated with the already flexible gear speed reducer line. It permits directly attaching a small gear reducer to a much larger one; consequently, the large unit has more than ample capacity to carry the heavy output shock loads, whereas, the input reducer is designed for the high speed to perfectly balance the overall design.

With this arrangement a reduction gear can have the same output capacity as it has input capacity. Due to the ease of assembly and disassembly, of the Crichton line, it is possible in a matter of minutes to change over to the stack system where weight and bulkiness is of prime importance.

Announced at the same time were four larger units extending to 18,219 horsepower at 1600 rpm with a 3½ to 1 reduction. These seven standard reducers will now cover a horsepower range at 1600 rpm of from 28 to 18,219 hp.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Flying Transport

The Vertol 44, which can carry 19 passengers or more than two tons of cargo, was put through its paces recently as a personnel transport, a flying crane, a tool for erecting oil rigs and as a vehicle for laying pipe line.

Vertol Aircraft Corporation, the manufacturer, is starting its first major sales campaign with a tour, which has already taken the tandem rotor helicopter to New Orleans and is continuing in Houston, Dallas, Tulsa and other cities. The aircraft is a passenger-cargo utility model.

The importance of this helicopter's capacity to the petroleum industry is its ability to transport the entire 175,656 pounds of the drill rig over a distance of 50 miles, out and back, in only 56 flying hours.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Processing System

Independent Exploration Co. has added the GeoData processing system to the services offered its clients.

The GeoData system, manufactured by Southwestern Industrial Electronics, will provide a record cross section, pen recorded on paper, which can be subsequently photographically reproduced. Cross-sections can be isopached or set to a desired reference plane. It also provides identical information permanently stored on magnetic tapes.

Tapes or visual records can be made with this system which have been trace mixed, filtered and corrected for weathering and elevation, as well as normal moveout. Filter analysis may be made of field records by playing the same record back through several filters and displaying it as a pen written paper recording.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

Standardized Engines

Completely new 206 cubic inch 57 bhp gas and natural gas engines are being built by Minneapolis-Moline Company in regular or heavy-duty enclosure styles.

New 206H-4A natural gas oil field engines are a high production valve-in-head design featuring MM separate cylinder heads and cylinder blocks. Heads and blocks are cast in pairs and are completely removable from the crankcase.

(This item supplements Minneapolis-Moline Co. data on Pages 3422-3423 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

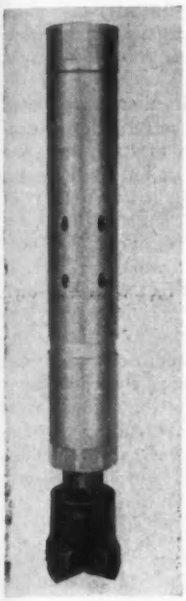
Ranger Helicopter

A payload increase of more than 40 percent for Bell's Model 47J Ranger helicopter was announced by Bell Helicopter Corporation. Certification for the new gross weight of 2800 pounds was made by the CAA after tests at the Bell plant.

Along with the increased gross limit, the Lycoming engine has been certified for operation at 240 horsepower, a 20 hp increase. The Lycoming VO-435 engine is rated at 260 hp for fixed wing aircraft operation.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Seismograph Hole Drill

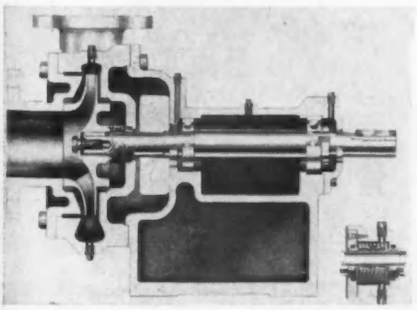


Gardner-Denver's new Mole-Dril adds power and versatility to rotary type drill rigs. Whenever hard formations are encountered, the Mole-Dril may be attached to the drill stem in place of the rotary bit. The drill stem conducts the compressed air supply to and rotates the drill. A tungsten carbide insert bit is attached to the tappet, thereby becoming an integral part of the drill. As a result the Mole-Dril gives maximum drilling efficiency, regardless of depth. The drill rod between the drill and bit is eliminated, and with it, the inherent energy dissipation of the conventional surface drill.

A direct air stream, at full line pressure, is directed through the bit to keep the hole face clean. Exhaust air from the drill is directed upward through ports midway up the drill, giving an assist in blowing cuttings up the hole.

(This item supplements Gardner-Denver Co. data on Pages 1945-1964 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.



Centrifugal Pump Line

A new line of high-speed, high-head centrifugal pumps for general water service has just been announced by Gardner-Denver Company.

All perform at high efficiency over a wider-than-usual range of service conditions, and offer features of design and material that assure exceptionally long life.

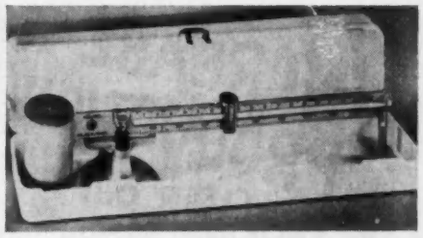
The features mentioned by Gardner-Denver include stainless steel shafts, oil-lubricated heavy-duty ball bearings, mechanical seals, accurately contoured casings and hydraulically balanced bronze impellers.

(This item supplements Gardner-Denver Co. data on Pages 1945-1964 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

DRILLING

4-Scale Mud Balance



The new Baroid four-scale and extended range Mud Balance has been developed to conform to the new API Code 29 for specifying the density of drilling mud. This balance has on the front the pounds per gallon and the pounds per square inch per 1000 feet of depth scales. On the back are the pounds per cubic feet and the specific gravity (kilograms per litre) scales.

The extended range eliminates the need for extra fixtures to cover the densities of mud now in use from the lightest to the heaviest.

This balance is die cast aluminum for greater uniformity in physical dimensions. The aluminum is polished and anodized for protection against the high pH drilling muds. The knife edge and level case

Fastest WAY TO PAYOFF in anything but cream pie

driltrol speeds the time from spud-in to production when changeable strata or directional drilling cuts you out of "easy pie" jobs.
(These drillable wing stabilizers can pay off in the soft stuff, too, because fast drilling can be maintained only when direction is controlled.)

With more weight on the bit, you get faster, *controlled* penetration. And, when necessary, washover is a matter of minutes!

More than 25,000 driltrol stabilizers have *speeded* drilling all over the globe; *controlled* drilling as fulcrums, hole straighteners, key seat guides, and preventatives for pressure differential sticking. Sizes to fit your job, priced at about half the cost of a single drill bit!
For fastest drilling in anything but cream pie jobs, get the recipe from your driltrol man!

CALIFORNIA
Ventura
MI 3-4366
Long Beach
GA 4-0461
Bakersfield
FA 5-6608
LOUISIANA
Lafayette
CE 4-2137
OKLAHOMA
Oklahoma City
ME 7-3325
TEXAS
Houston
OL 4-4871
Dickinson
8-4421

WYOMING
Casper
3-3360
CANADA
Edmonton
390-223, 3-6160
Calgary
AM 2-5331, 692-922

EXPORT
New York—CI 6-0970
Los Angeles—RI 9-8513

driltrol 1361 E. Hill St., Long Beach, Calif.

INCREASE PRODUCTION

CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less down-time, use world famous Miller Sand Pumps.

SAND PUMP SIZES

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 In.
Lengths—20, 25, 30 ft.

Composite Catalog, Page 3419

Write for descriptive price list

MILLER SAND PUMPS

Miller Sand Pump Co.

General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK CITY 20, N. Y.

for leakproof, pressure-tight connections

use TiteSeal®

SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

7 BASIC BLENDS

LIQUID WRENCH®

The super-penetrating rust solvent

LOOSENS rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*... yet is absolutely safe for all metals and alloys.

2171

At Industrial, Automotive, Hardware, Plumbing Jobbers

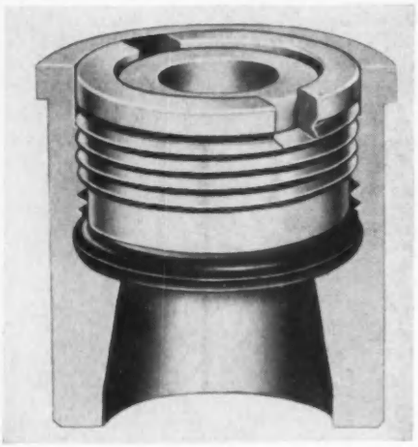
SOLDER SEAL

RADIATOR SPECIALTY CO.
Charlotte, North Carolina

have been built into an integral unit for greater visibility and protection of the level glass.

(This item supplements Baroid Division, National Lead Co., data on Pages 642-645 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.



Threaded Flow Nozzle

The H. C. Smith Oil Tool Co. has announced the development of a new, threaded flow nozzle—the first to be used in three-cutter jet rock bits. Thoroughly tested and proven by the manufacturer, the new nozzle is so designed as to permit easier, quicker, and completely foolproof installation or replacement in the field. Instead of the customery knockout rod, pliers and gage bar, a single wrench is the only tool required for installation or removal.

An "O"-ring in the simple unitized assembly is compressed as the threaded flow nozzle is screwed tight. The compressed "O"-ring thereafter acts as a "shakeproof" elastic stop nut to prevent backing out of the nozzle while running in the hole. And during the drilling operation, fluid pressure on the same "O"-ring positively locks the nozzle and retainer in place.

(This item supplements H. C. Smith Oil Tool Co. data on Pages 4825-4852 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

New Catheads and Tongs

Ben F. Kelly Co., Inc., has announced new, smaller, lightweight spinning line and breakout catheads. The Model 10 has an overall length from end of shaft of 15⅜-inch with an overall diameter of 12⅝ inches. Distance to center of spinning drum is only 4¾ inches. Installed weight is only 225 pounds.

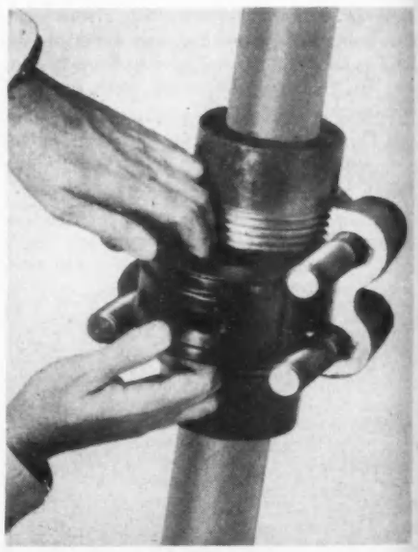
Features include hydraulically operated clutch and 95 percent parts interchangeability between breakout and spinning line units. Sealed bearings eliminate lubrication connections and prevent possibility of grease getting on clutch surfaces.

The Model 10 was designed for core drills, pulling units and workover rigs. It can be used up to 4000 feet with 4½-inch drill pipe.

Also announced is a new addition to the KelCo line of tongs (pictured) designed especially for workover rigs. By using interchangeable dies, the new tongs have a capacity from 2⅜-inch O.D. tubing through 4⅛-inch O.D. workover drill collars. The new tongs are built on the full-grip principle which prevents die cutting and crushing of pipe.

(This item supplements Ben F. Kelley Co., Inc., data on Pages 2825-2834 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E10** on Readers' Service Card, last page this issue.



Flex-Seal Mud Valve

Field disassembly and replacement of wear rings and the gate packer in the new Type "R" Flex-Seal mud valve made by Cameron Iron Works, Inc., is as simple as opening the hood on an automobile, since the subs and bonnet cap remain rigidly in place in the mud line while the bonnet may be removed to expose the parts for replacement.

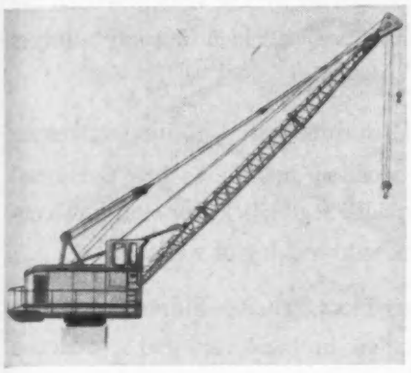
Modified subs are tack welded to the bonnet cap to form a rigid unit. These welds are structural only. They are not subject to pressure and by removing them, worn subs may be easily replaced. But the modified subs thus welded permit the wear rings and gate packer to be changed as a unit without moving the subs apart or taking the bonnet cap from the line, and they make misalignment impossible.

Another field repair feature of the new valve is the use of four studs extending

from the bonnet cap and four extended cap nuts instead of the threaded-through nuts used in old mud valves to hold the bonnet and bonnet cap assembled. With this feature the studs and threads are now completely covered and are not exposed to corrosion or damage.

(This item supplements Cameron Iron Works, Inc., data on Pages 1141-1200-H of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E11** on Readers' Service Card, last page this issue.



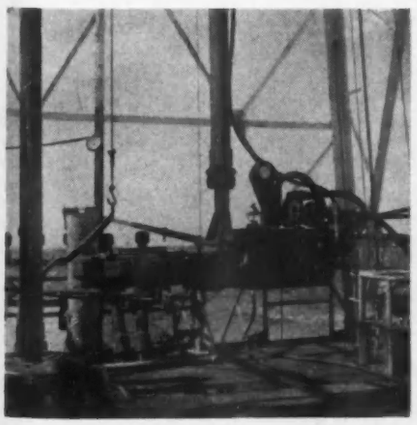
Stationary Crane

Production of a new crane designed specifically for stationary pedestal mounting or on offshore drilling platforms has been announced by the Insley Manufacturing Corporation. Rated capacity of the new crane is 35 tons at a 15-foot radius.

Standard features of particular importance to stationary operations include: large cable capacity drums, independent boom hoist, a boom head design which permits simultaneous operation of a main load line and a whip line, full vision, all weather cab with extended and elevated operator's station, walkway and handrailing, dual telescoping boom backstops, safety hook on hook block, rigid extra high boom gantry, brake type cab lock and full view boom radius indicator for accurate radius check.

Design features include a machinery deck constructed as a one-piece weldment with ribbed side stands, involute shaft splining and anti-friction bearings.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.



Versatile Casing Tong

The Foster Cathead Company is making ready for the market a hydraulic casing tong capable of handling all size casings from 5½ inches to 9⅝ inches O.D., and with special jaws this tong can accommodate 10¾-inch casing.

The tong is of the same basic design as the Foster tubing tong. Like the tubing tong, the casing tong stays on the string of casing for the entire trip. This is an advantage in that it reduces make-up time to one-third of that required with catheads. In a recent trial run near Odessa, Texas, on a 6000 foot well, the average time on make-up on 8⅝-inch casing was ten seconds.

Another advantage of the tong staying on the string of casing for the entire trip is that the entire assembly of working parts can be completely enclosed, eliminating the danger of catching clothing or members of the body in these working parts.

(This item supplements Foster Cathead Co. data on Pages 1845-1876 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

Hot Water Mast

The Lee C. Moore Corporation recently fabricated a 94-foot high trailer mounted mast destined for a drilling assignment in Iceland. The Moore mast is part of a complete rotary rig that will drill, not for oil and gas, but for hot water.

Oil and gas have never been found in Iceland, which explains why 35 percent of the capital city of Reykjavik is heated by hot water piped into the city. Source of this hot water is springs supplemented by hot water produced from depths up to 700 feet at the present time. The balance of Iceland's chief city is being heated by oil which has to be imported.

The Lee C. Moore mast on the Iceland rig will be drilling to a depth of 2000 feet, but it is designed to accommodate a larger drawworks for greater depths at a later date. A specially designed mud system will be used for cooling the mud slurry.

(This item supplements Lee C. Moore Corp. data on Pages 3597-3632 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E14** on Readers' Service Card, last page this issue.

PERFORATE TUBING IN THE WELL

KINLEY TUBING PERFORATOR

M. M. Kinley Company
Licensees

ABILENE, TEXAS
Hudson-Eads, Inc. 2-5331
BAY CITY, TEXAS
J. P. Graham ..... CI 5-4526
BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc. ..... TE 5-7046, ZF 8-2023
CASPER, WYOMING—C. A. White 3-5264
FORT MORGAN, COLORADO—C. A. White 919
GLENDIVE, MONTANA—C. A. White ... EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co. 3-5396
HOUMA, LOUISIANA—Cameo, Inc. 7330
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc. ..... CA 5-1103
KILGORE, TEXAS—B. M. Davis 5541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc. ..... CE 5-6770
Cameo, Inc. ..... CE 5-3124
LIBERAL, KANSAS
Rainbo Service ..... Main 4-3598
MIDLAND, TEXAS
Luccous Service & Eqpt. Co. ..... MU 2-1631
NEW ORLEANS, LOUISIANA
Assoc. Eng. & Eqpt., Inc. ..... VE 5-4983
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co. ..... ME 4-2131, ME 2-3045
PETTUS, TEXAS
Eddie Jones Eng. Co., Pettus 16; Beeville, FL 8-1218
SHREVEPORT, LOUISIANA
Cameo, Inc. 8-3615
VICTORIA, TEXAS—Cameo, Inc. ..... HI 3-9521
WHITTIER, CALIFORNIA
Kline Wire Line Co. ..... OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. 2-3767, 2-8584, 3-4690

how to trick Your Boiler

into Maximum Performance, is no trick at all

Just Use

SAND-BANUM

PURE COLLOIDAL CONCENTRATE

Ounces Only Once a Week
Remove and Prevent Boiler Scale

●

for Maximum, Clean Burnability of ALL Grades of Fuel Oil—You Can Count On

Instant Acting

SABANOL

THE HOMOGENIZING FUEL OIL TREATMENT

Stocked by Leading Supply Houses
Gulf Coast District Representatives
WESTERN SAND-BANUM CO.
1717 Chenevert Street, Houston 2, Texas

AMERICAN SAND-BANUM CO.
ESTABLISHED 1926
MEADOW BROOK NATIONAL BANK BUILDING
FREEPORT, NEW YORK

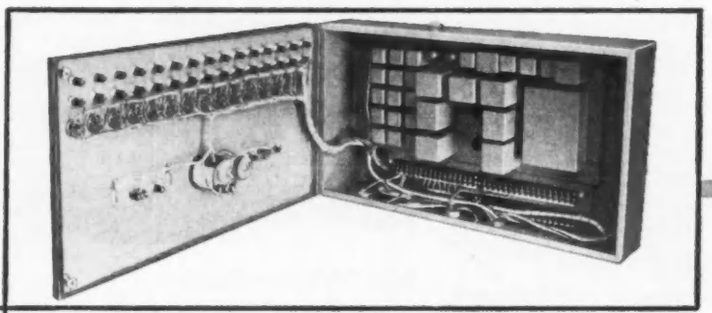
AUTOMATIC LEASE CONTROL

Individually designed and engineered!

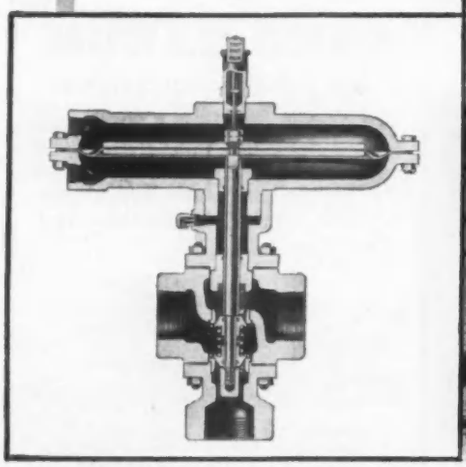
The line illustration on the right represents a typical automatic well test system. The "Cyclotest" Automatic Well Test Control Panel, pictured below this illustration, is connected to three-way solenoid actuated diverting valves installed in each flow line production manifold. A valve, when actuated, diverts the flow of oil through the well test equipment, comprised of a test separator or heater-treater and meters for oil, water and gas. Each meter actuates a momentary contact for each unit of production. This test information, in the form of electrical pulses, can be recorded by various pens in an associated strip chart operation recorder or in digital form by the CSC "Cycloprint" DATA Printer, shown below the illustration on the right. Also recorded are well identification numbers and duration of tests.

If Fisher Type 1620 three-way, 3 position valves are used in the production manifold, the "Cyclotest" panel can be provided with clocks for well flow control for automatic stop-cocking of wells.

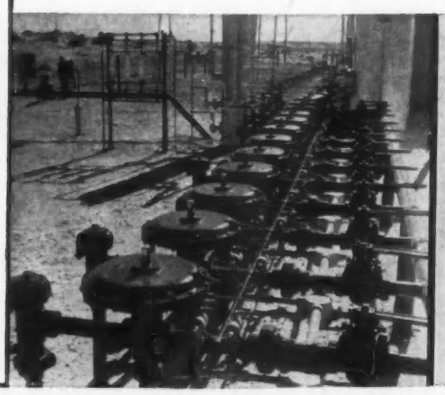
High Level Safety Float Switches, Fisher Type 2800-252V, are installed in both test and production separators. High level in Test Separator carries oil to be diverted back through Production Separator; high level in Production Separator can be used to actuate a lease shut-in circuit.



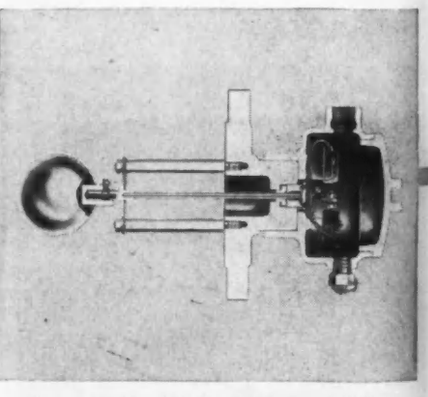
Internal Construction of CSC "Cyclotest". Individual relays are hermetically sealed and plug-in. This minimizes the need for maintenance and at the same time makes servicing of this unit quite simple. The sub-base on which the plug-in components are mounted is hinged and swings out for easy access to all internal wiring.



The Type 1620, pictured above, is a three-way, three-position valve. With no pressure on the diaphragm both ports are closed, so that this valve can be used for production control in addition to automatic well testing. The body is rated at 1500 lbs. W.O.G. working pressure and has 2" screwed connections.

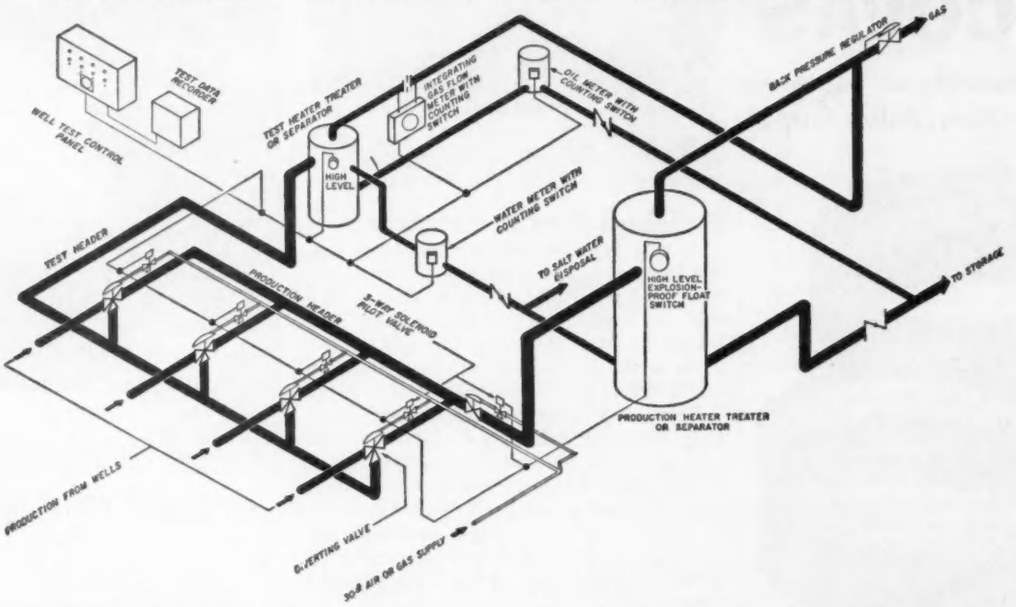


Pictured above are Diverting Valves for Well Test Manifold. Fisher offers two valve types for this service. For straight three-way service at low pressures the Type 1663A is recommended. This valve is spring loaded, diverting to the (test) position only when air is applied under the diaphragm.



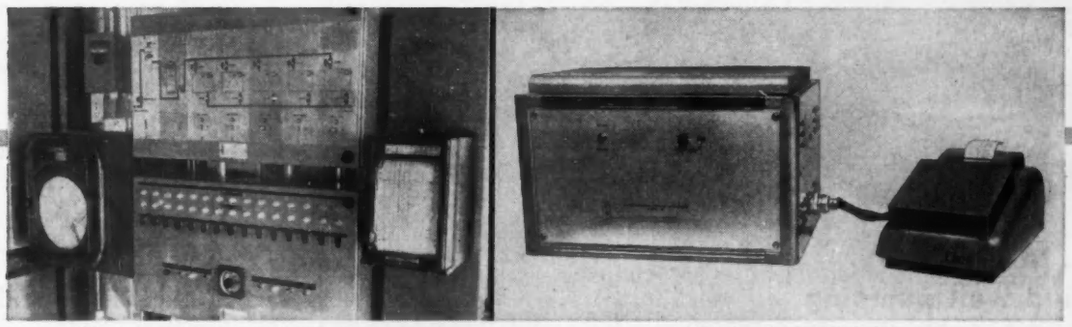
Float Level Control. The Fisher Type 2800-252V, an on-off type float switch, uses a flexure tube assembly for transmitting float motion to a Micro switch in an explosion-proof housing. Also available with Type 2805 pneumatic snap-acting pilot—interchangeable on same housing.

AND WELL TESTING EQUIPMENT



The left illustration below shows the controllers and recorders for a combination automatic tank switching and automatic well testing installation. The graphic panel is a CSC "Cyclotest" Automatic Well Test Controller for programming the testing of 15 wells. The recorder on the left is the integrating gas flow meter. On the right is a multi-pen operation recorder providing a permanent record of well test data.

The pilot lights on the "Cyclotest" indicate which wells are flowing straight to the Production Separator and which well is on test. The row of switches directly under the lights provide for by-passing wells from test sequence, for shutting wells in or for putting them on test independent of the controller. In the lower center is a 1-30 hr. timer which determines the duration of the test.



"Cyclotest" Automatic Well Test Controllers *"Cycloprint" Data Printer*

Pictured on the right in the above illustration is a "Cycloprint" Automatic Data Printer which is a multi-channel unit designed to receive pulse information from as many as 21 different sources and store this information until called for. A typical application is the recording of well test information such as barrels of oil and water, MCF of gas, test time, lease identification, date and time. The information is printed in digital form on adding machine tape.

FOR CONTROL SYSTEM DESIGN:

CONTROL SPECIALTY CORPORATION

(A Subsidiary of FISHER GOVERNOR COMPANY)

Box 4524, Houston 13, Texas

FOR VALVES AND LIQUID LEVEL CONTROLS

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls

SINCE 1880

We've gone all out on DARCOVAS

. . . The Original Composition Valve Cups

. . . to give you unmatched well pumping economy and efficiency!

Darcovas are the truly performance-engineered valve cups, seating cups and rings. Designed to do more than "fill a barrel". Designed to prolong pumping efficiency and reduce down-time and maintenance! Features include 100% nylon composition, range of textures for every condition, and complete range of precision sizes for every make or size of pump.

SEND FOR BULLETIN 5502

And since there's no substitute be sure to specify DARCOVA

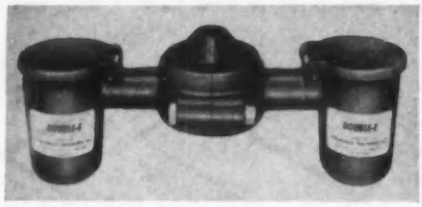
DARLING VALVE & MANUFACTURING COMPANY

DARCOVA ®

THE ORIGINAL COMPOSITION CUP

WILLIAMSPORT 28, PA.

PRODUCTION



Polished Rod Lubricator

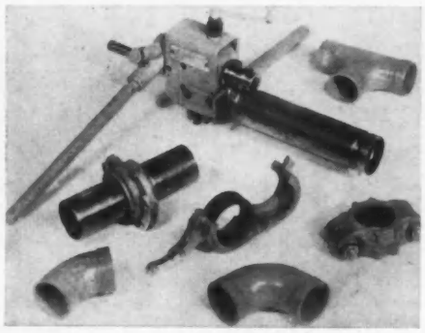
A new type of polished rod lubricator has been acquired from the Drovil Company and is now being manufactured and sold by Equipment Engineers, Inc. The lubricator is said to be the answer for those wells that are continually "burning out" stuffing box rubbers.

Twin pots on either side of the new-style Double-E lubricator hold a pint of oil each. This lubrication is gradually fed to the polished rod by means of wicks and felts. Whenever the well happens to be "pumping dry" the pumper need have no concern as this lubricator continues to keep the polished rod cool and smooth running.

The lubricator rests on top of any stuffing box and, due to its split design, can be installed in several minutes.

(This item supplements Equipment Engineers, Inc., data on Pages 1618-1619 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E15** on Readers' Service Card, last page this issue.



Welded Steel Tubing

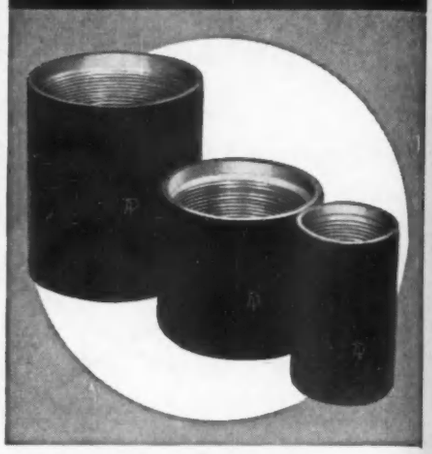
Mill grooved light wall electric resistance welded steel tubing for use in mechanically coupled piping systems is now being produced by the Steel & Tubes Division of Republic Steel.

The tubing is particularly suited for temporary, semi-permanent or permanent mechanically coupled piping systems in the mining, petroleum, construction and road building fields.

Since the groove forming operation does not require removal of metal from the tubing wall, the latter is ideally suited for application with relatively high pressure mechanical couplings. The combination of uniform thickness and simple mechanical couplings gives piping engineers the opportunity to select tubing of suitable wall thickness for the pressure and conditions of the job.

For more data, circle **No. E16** on Readers' Service Card, last page this issue.

ALL COUPLINGS for the oil industry



A.P.I. LINE COUPLINGS

Sizes ⅛" through 12", 14" and 16" O.D. Black and Galvanized. Recessed, Taper Tapped ¾" per foot.

A.P.I. CASING COUPLINGS

Short and Long, sizes 4½" through 13⅜". All threads 8 round, ¾" taper per foot. Combination casing couplings also available.

A.P.I. TUBING COUPLINGS

Non-Upset sizes 1.900" through 4½". Upset sizes 1.660" through 4".

OTHER OIL INDUSTRY ITEMS

Couplings-Standard Merchant, 3000 and 6000 lb. Hydraulic and all other types of special couplings.
Hex Bushings, Square Head and Hex Head Solid Plugs, Nipples, Unions, Steel Socket Weld Couplings and Caps.

CAP **CAPITOL**
MFG. & SUPPLY CO.
COLUMBUS, OHIO

COUPLINGS — NIPPLES — UNIONS — RADIANT HEAT FITTINGS — FURNACE COILS — WELL SUPPLIES — STEEL PIPE FITTINGS

New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Hydraulic Nomograph

The Texsteam Corporation nomograph consolidates all factors essential to an engineered selection and powering of long stroke hydraulic pumping units. Complete instructions plus the simple, heavy lined nomograph design permits a rapid calculation of hydraulic pumping unit requirements by untrained personnel.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Concrete Pile Manual

Raymond Concrete Pile Company has recently published a brochure entitled, "Raymond Cylinder Piles of Prestressed Concrete." The 20-page catalog describes and illustrates the manufacture, versatility and economic applications of prestressed concrete cylinder piles and related prestressed products. Information is given on the merits of prestressed concrete cylinder piles for foundations of bridges, waterfront and offshore structures. Numerous photographs of installations and drawings of suggested designs are shown in the brochure.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Coupling Booklet

A new book describing Link-Belt Company's complete line of improved geared flexible couplings has just been released. Book 2775, a completely new 12-page publication, details pertinent application and selection data for couplings with maximum bores ranging up to seven inches and ratings from 2½ to 572 horsepower per 100 rpm.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

V-Belt Drive Catalog

The Dayton Rubber Company's recently published 24-page oil field drilling rig V-belt catalog offers the most comprehensive and detailed drive information of any publication of its type. It contains drive design recommendations based on actual drilling operation practices. Outstanding in the Dayton catalog are complete tables of pre-engineered V-belt drives.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Pumping Bulletin

The Fluid Packed Pump Co. announces a new 16-page illustrated dual zone pumping brochure. A compilation of selection charts, rod and tubing assemblies, schematic drawing and pack-off sub assemblies, published to assist in the proper design of dual zone installations.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Ratio-Compound Brochure

The Fluid Packed Pump Co. announces a new four-page illustrated ratio-compound pump brochure. Function of the ratio-compound principle, parts lists and selection charts comprise a brief but informative bulletin.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Motor Control Brochure

The latest design features in Allis-Chalmers front access, high voltage starters (Type HO for 2300 to 5000-volt motors which provide maximum accessibility, protection, performance and space economy are given in a new bulletin released by the company.

The bulletin points out how the starter's roll-out type air-break contactor (Type 256A) makes inspection and routine maintenance of the unit easy. The starter is available with oil-immersed contactor where dust, dirt, moisture and corrosion are problems. It fits in the same space as the air-break contactor.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

V-Belt Drive Guide

Dodge Manufacturing Corporation has issued a comprehensive manual to assist plant engineers and others with power transmission problems. This 108-page book is packed with easy-to-read information on selection and operation of Dodge V-belt drives. Its 8½ inch by 11-inch pages are arranged in sections covering standard, variable speed and special drives, taperlock sheaves, sealed-life V-belts, and taperlock bushings and hubs.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

Silent Chain Drive Booklet

A comprehensive book on the subject of silent chain drives, Book 2425, available from Link-Belt Company, contains 88 pages of detailed enginering data and illustrations of silent chain's versatility in a wide range of applications.

Book 2425 contains tables of service factors, ratings, chain length and center distance computations. Pre-engineered stock drives are listed in one 16-page section.

To get a copy, circle **No. E25** on Readers' Service Card, last page this issue.

Junk Basket Bulletin

A four-page folder covering a new product, the Bowen Itco junk basket, is now available from the manufacturer. A two catcher junk fishing and coring device, the new tool was designed to simplify fishing and make possible a one-trip operation. Cutaway drawings and complete description of tool, parts and prices are given.

A sintered carbide-dressed shoe is shown in detail, as well as mill-type and flat-bottom shoes.

To get a copy, circle **No. E26** on Readers' Service Card, last page this issue.

CF&I Wire Catalog

A 72-page illustrated catalog describing the complete line of CF&I-Wickwire wire has been made available by the Colorado Fuel and Iron Corporation. The new catalog gives complete ordering specifications for all CF&I wire including manufacturers low carbon coarse wire, high carbon fine and specialty wire, low carbon fine and specialty wire and flat and shaped wire.

To get a copy, circle **No. E27** on Readers' Service Card, last page this issue.

Extreme Line Casing Data

J & L extreme line casing for deep, high-pressure wells is presented in a new eight-page bulletin by Jones & Laughlin Steel Corporation. Design features, specifications and new facilities for manufacture and testing are given.

To get a copy, circle **No. E28** on Readers' Service Card, last page this issue.

Slush Pump Brochure

National Supply Company's fluid end parts for slush pumps are presented in a new eight-page illustrated Bulletin 464 which also contains installation and maintenance tips. Parts include Type G-1 fluid valve and seat, newest "Dual Seal" fluid piston, "Blue Stripe" and "Blue Chrome" piston rods and packing, and Nationaloy fluid cylinder liners.

To get a copy, circle **No. E29** on Readers' Service Card, last page this issue.

Advertisers' Index

• Dot preceding name of advertiser indicates that detailed data on products and services of the firm will be found in current 22nd (1957) edition of The Composite Catalog of Oil Field Equipment.

A

• Abegg & Reinhold Co. 217
Aero Service Corp. 111
• Ajax Iron Works 231
• American Iron & Machine Works Co. 18-19
American Sand-Banum Co. 239b
Antara Chemicals, Div. General Aniline & Film Corp. 25
• Axelson Manufacturing Co. Division U. S. Industries, Inc. 30-31

B

• B & W Incorporated 187
• Baash-Ross Tool Company Division Joy Manufacturing Co. 123
• Baker Oil Tools, Inc. ..... 92 and 170-171
Bank of the Southwest 65
• Baroid Division National Lead Co. 53-54
• The J. B. Beaird Co. 175
• Bethlehem Steel Co. ..... 34, 85 and 141
• Black, Sivalls & Bryson, Inc. 206
• Borg-Warner Corp. 1
• S. R. Bowen Company 178
• Brakesol, Inc. 212b
• The Brewster Company 107-108
Brook Motor Corp. 228b
• Brown Oil Tools, Inc. 16
• Byron Jackson Tools, Inc. Division Borg-Warner Corp. 1

C

Cable Engineering 228c
• Cabot Shops, Inc. 37
• Cameron Iron Works, Inc. 61
• Capitol Mfg. & Supply Co. 242b
• Cardwell Manufacturing Co. 14-15
• Catawissa Valve & Fittings Co. 218a
• Clark Bros. Co. 39
Classified Advertising 226
• The Colorado Fuel and Iron Corp. 17
• The Composite Catalog 82-83
• Continental Motors Corp. 33
Corrosion Rectifying Co. 212c

D

Darling Valve & Mfg. Co. 242a
• Davey, Paxman & Co. Ltd. 40
Dayton Rubber Co. 48
Dover Corp. 70
• Dowell Incorporated ..... 72, 138-139 and 176
• Dresser Industries, Inc. ..... 39, 125 and 126
• Drilling & Service, Inc. 20
Driltrol Co. 237

E

• Eastman Oil Well Survey Co. 35
• Edward Valves, Inc. 184
Elder Trailer & Body, Inc. 62a
The Elgen Corporation 219
• Emsco Screen Pipe Co. 136
• Equipment Engineers, Inc. 22

F

• Fisher Governor Co. 240-241
• Fluid Packed Pump Co. 58-59
Ford Motor Co. 188-189
• Foster Cathead Co. 62b
• Franks Division Cabot Shops, Inc. 37

G

G & H Towing Co. 68
Galloway's Pipe Guard 212a
• Gardner-Denver Co. 52
General Aniline & Film Corp. 25
• Globe Oil Tools Co. 130-131
• The Guiberson Corp. 38

H

• Halliburton Oil Well Cementing Co. ..... 98 and 134-135
• Hands-England Oilfield Equipment Ltd. 216
• Harbison-Fischer Mfg. Co. 208
• Herb J. Hawthorne, Inc. 103
• Hercules Motors Corp. 23
• Hercules Tool Company 203
The Holcombe Co. 21
• HOMCO 193
• Hughes Tool Company 248

I

• IDECO Division Dresser Industries, Inc. 126
• Ingersoll-Rand Co. 204
The International Nickel Co. 11, 57

J

• Jensen Bros. Mfg. Co. 207
• Johns-Manville Corp. 157
• Jones & Laughlin Supply Div. 49
• Joy Manufacturing Co. ..... 55 and 123

K

• K & G Oil Tool and Service Co. 192
Kern Instruments Inc. 194
• Keystone Supply Co. 140b
• King Oil Tools 221
• M. M. Kinley Co. ..... 213a and 239a
• Kinzbach Tool Co. 110
Kirklees Limited 44

L

• Lane-Wells Company 247
• Larkin Packer Co. 51
• The Layne & Bowler Co. 200
• LeGrand, Sutcliff & Gell 201
• Link-Belt Company 7
• Lone Star Steel Co. 2
• Lufkin Foundry & Machine Co. 142

M

• Magnet Cove Barium Corp. 125
• Jas. P. Marsh Corp. 36
• John N. Martin Mfr., Inc. 209
• Martin-Decker Corp. 26
• McCullough Tool Company 229
• McKissick Products Corp. 46
Midwest Oil Register 213b
• Miller Sand Pump Co. 238a
Milwhite Mud Sales Co. 32
• Mixing Equipment Co., Inc. 13

N

The National Bank of Commerce 81
• National Lead Co. 53-54
• The National Supply Co. 87-91
• National Tank Co. 151
• W. C. Norris, Mfr. Division of Dover Corp. 70

O

• Oil Center Tool Co. 41
• Oil States Rubber Co. 224b
• Oil Well Supply Division United States Steel Corp. 8, 10
• Otis Engineering Corp. 206

P

Pacific Coast Borax Company Division United States Borax & Chemical Corp. 60
• Page Oil Tools, Inc. 28
• Perforating Guns Atlas Corp. 195
Petroleum Electric Power Assoc. 64
Petroleum Equipment Suppliers Assoc. 235
Chas. Pfizer Co. 158-159

R

Radiator Specialty Co. 238b
Reading & Bates Offshore Drilling Co. 140a
• Rector Well Equipment Co. 215
• Reda Pump Co. 224a
• Reed Roller Bit Co. 210-211
• Rockwell Manufacturing Co. 198
Rogers Geophysical Co. 185
The Royal Bank of Canada 214

S

• Sargent Engineering Corp. 173
• Schlumberger Well Surveying Corp. 45
• Servco Company 42
• Shaffer Tool Works 236
• H. C. Smith Oil Tool Co. 191
Southern Engine & Pump Co. 218b
• Spang & Company 225
Standard Oil Company of California 9
Standard Oil Company (New Jersey) 24
• Stewart & Stevenson Services, Inc. 232-233
• Joe Stine, Inc. 186
Stitt Ignition Co. 228a

T

• Technical Oil Tool Corp. 112
Texas Employers Insurance Assoc. 29
• Thornhill-Craver Co. 202
Trading Post Section 226
• Tretolite Co. 47
• Tuboscope Co. 63

U

• U. S. Industries, Inc. 30-31
United States Borax & Chemical Corp. 60
• United States Steel Corp. 8, 10
• Universal Packing & Gasket Co. 50

V

• Visco Products Co. 144

W

Wagner Electric Corp. 60
Warren Automatic Tool Co. 230
• Waukesha Motor Co. 12
Waukesha Sales & Service, Inc. 137
• Weatherford Oil Tool Co. 27
Welex, Inc. 66-67
• Well Equipment Mfg. Corp. 43
• White Diesel Engine Div. The White Motor Co. 56
• Wilson Manufacturing Co. 119
• Wilson Supply Co. 196-197

Y

• The Youngstown Sheet & Tube Co. 114